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EDUCATION AND ECONOMIC GROWTH

Richard H. P. Kraft

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EDUCATION AND ECONOMIC GROWTH

PROCEEDINGS OF THE
FIRST ANNUAL CONFERENCE ON
THE ECONOMICS OF EDUCATION

Edited by Richard H. P. Kraft

Sponsored by the Educational Systems
Development Center, College of Education
The Florida State University
Tallahassee, Florida

1968

Educational Systems Development Center

Preface

The papers in this volume were originally delivered at the First Annual Conference on the Economics of Education sponsored by the Educational Systems Development Center, and held at Florida State University in Tallahassee, on December 15, 1967.

The editor wishes to express his thanks for the help of the staff members of the Center in arranging the Conference and in the preparation of this volume. Most especially he would like to thank Dr. Frank W. Banghart, who contributed valuable ideas and suggestions that affected the entire undertaking.

Richard H. P. Kraft

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Part One

Planning Education for Economic and Social Development

Introduction: Education and Economic Growth

Richard H. P. Kraft

For educators and economists, a keen interest in the economics of education is by no means idle activity. I hope that in years to come more and more educators will examine the conceptual structure of the economics of education. And although many scholars doing research in this field will receive an occasional elbow in the ribs from the professionally orthodox side of the discipline, I am convinced that the research will be extremely influential in laying the groundwork for the policy determinations which will guide education in the future. Many educators have begun to realize that a great number of their "models" do not reflect the real world. It seems to me that the phenomenon which can be observed in the field of economics of education is similar in content to that which changed the structure of biological science. Robert Ardrey, in his book The Territorial Imperative(1) tells how biological science was enriched by amateur "biologists," e.g., amateur animal watchers. These amateurs observed the various species in nature while the "professionals," the professors of biology, continued their studies from the more traditional and conventional vantage points of laboratories. No wonder that contradictory evidence was piling up, and no wonder that professional biologists soon began to notice that their research - and consequently their science - was out of touch with reality.

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(1) New York: Atheneum, 1966.

More and more economists and educators today ought to feel a sense of kinship to those amateur biologists, for in many respects education is in a similar situation to that in which biological science was years ago. We have to realize that our "input-output" - models often do not account satisfactorily for what is observed in the real world.

Part One of today's conference will deal with Planning Education for Economic and Social Development. During the next few hours the speakers will discuss the large range of actions which educational planners can take to plan - what is called "quality education." Topics will include: How to Control Ineffective Performance, Review of the Performance in Terms of the Need of the Educational Plan, the Stability of Policies, and the Specifics of Policies and Procedures. Large systems have a clear need to plan ahead, for their size means that they face serious costs if they are forced to improvise. One of the major advantages of the largeness of Florida's school system is the opportunity that it can provide for decentralization and specialization of function.

However, it must be understood that changes within this system can be effected only within a framework of organizational objectives, policies, and procedures that are well understood and accepted by all echelons.

Regarding educational long-range planning it must be observed that (1) the key to success is the quality of the plan, (2) the extent to which educational planning is successful depends in large measure on the quality of the people assigned to do the planning, and (3) if an educational system has the foresight to take action in time to acquire resources essential to its future work, its level of performance will noticeably be better than if it has failed to do any of these things.

The afternoon hours will be devoted to discussions on Strategies of Human Resource Development. The speakers will address themselves to the problem of relating educational outcomes to economic growth. The underlying idea is that investment in education has predictable and positive effects on the development of human talent, and the development of talent in turn has positive and measurable effects on economic growth. The statement that there is a direct relationship between the quality of education offered and the rate of economic growth, suggests that economic growth can be accelerated by means of an improvement of the educational system.

No wonder that more and more politicians and educators show interest in the economic value of education. A great number of studies have become available and there are in general some quite new things about the relationship between expenditure levels and various aspects of "quality education" as we conceive it today. In addition, and this is a rather new trend, there is the conscious effort on the part of politicians and educators to make education a major force and an integral part of economic development.

The concepts of effectiveness and efficiency are not new. They are economic terms. All these terms were originally formulated and used in connection with the theory of the firm. The actual "effectiveness" of a particular organization or system, for instance an educational system, is determined by the degree to which it realizes its goals, whereas the "efficiency" of a system is measured by the amount of resources used to produce a unit of output.(2) In this context, inputs and outputs are clearly defined, and efficiency is the primary objective. In reality, however, educational inputs as well as educational outputs, are much too often characterized by the fact that they are not defined too clearly, and that effectiveness and efficiency do not go hand in hand.

The application of efficiency-criteria to the United States' education system, for instance, shows that the educational output at present is neither identical with, nor necessarily related to, the educational goals. An example will clarify this statement. Assuming that education has a substantial income value for those who obtain it, one might argue that high levels of educational attainment insure relative stability of employment and earnings. It is widely realized, however, that for many people a given number of years of schooling has not the same income value as it has for the majority population.(3) The background of this problem is widely known but what is less widely recognized is the fact that the "underinvestment in human beings" also results in a weakened occupational structure. To avoid this waste of manpower, this squandering of human resource capital, conditions must be created that make it possible for people to enhance their capabilities as producers and consumers by investing in themselves. But only if education increases the future productivity and consequently uplifts the earnings-level, only then do the contributions of education and training become a source of economic growth.

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(2) See Amitai Etzioni, Modern Organizations (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964).

Any attempt to apply the efficiency concept to education raises a great number of questions. Here are some: Can we measure "social costs and benefits" of education? Can we establish a firm relationship between "educational inputs" and "education outputs?" Are we able to control the inputs so as to maximize the outputs? Can we quantify any relationships between resource inputs in education and economic growth?

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(3) See Walter Fogel, "The Effect of Low Educational Attainment on Incomes: A Comparative Study of Selected Ethnic Groups," The Journal of Human Resources (Vol. I, No. 2, Fall 1966), p. 23.

During the past twenty years and more, many educators and economists have attempted to answer these questions. They have been engaged in developing theories, assembling facts, undertaking analyses of selected areas of the broad field of the economics of education. An analysis of the data relating to educational investment, for example, will immediately and inevitably raise questions as to the "consumption" and "production" aspects of education, as well as to the efficiency of educational programs. Vast educational expenditures can be pure "waste" from the standpoint of production. The immense number of "liberal arts" students in developing countries, for instance, who, after graduation are usually unemployed if not unemployable, clearly indicates that the traditional vocational choices and the productivity needs are not necessarily related to one another.

The usefulness of such calculations has not yet been fully explored. In view of the high drop-out rates in secondary schools in the United States, it is my opinion that counselors should disseminate detailed information about the monetary gains from different occupations (or the estimated net private discounted values of various occupations) so that students can better decide whether to remain in school or not. This seems to me a very important task, since many students - especially members of minority groups - are either unaware of the extremely high monetary gains from technical occupations, or are misdirected students who follow the widely spread tendency to put a liberal education "above" a technical education. A change in preference patterns of the students might arise if society, through the state governments, would grant incentives to those who pursue technical education.

Finally, I ask the question: "What impact will this conference have?" Perhaps, no particular burning problem will be solved. If however, those of us present feel the necessity for a more scientific approach to educational planning, if we acquire the idea that there must be consensus among those who make and those who implement plans, and if we agree that forward-looking planning and associated-systems study and close attention to system interactions are the most important of all possible concerns of education today, we have profited. In conclusion, I would like to cite Coombs who once pointed out that "educators and economists, as their recent dialogues have demonstrated, have much to teach each other, and once each has learned that, they make an agreeable and powerful team."[4]

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[4] Philip H. Coombs, "The Adjustment of the Educational Structure to the Requirements of Economic Development," International Review of Education, Vol. X, No. 1, 1964, p. 56.

An Optimum Enrollment Policy for Developing Countries

Hector Correa

One problem that developing countries face is the lack of enough or adequate school facilities. The problem takes many forms. One of these is the existence of a large group of persons of school age who have never enrolled in the educational system. Another form is the half-time school day created in order to permit twice as many children to use the same school facilities.

A country in which these conditions exist must provide schools not only for the persons reaching the minimum school age, but also for the backlog of persons who are still of school age but who have never enrolled, and for half the children in schools with double enrollment.

In this paper, a method for minimizing the investment necessary to achieve this goal is presented. In the example included, it will be seen that this method can result in a substantial reduction of expenses.

The basic idea of our method is that if a country in any one year manages to open schools that will take care of all the backlog of school-age population not previously enrolled, or all the part-time students, it will be wasting its resources. The school facilities made available for the backlog of non-enrolled and part-time students will be under-utilized when, in the following years, only those reaching six years of age enroll in the educational system. If the enrollment of the backlog of non-enrolled and part-time students is spread over several years, it is possible to reduce the wastage of some resources.

Below, the question of the minimum amount of investment needed to enroll the backlog of non-enrolled, plus population reaching six years of age, is put in the form of a linear programming problem.

Let us suppose that in year t=0 a country has a backlog of non-enrolled persons of

$$(1) \qquad \sum_{j=0}^{H} p_j^0$$

where p_j^t is the number of non-enrolled persons of age j in year t, and H is the maximum age at which a person can begin his schooling. Let us suppose that the country wants to open schools for the entire backlog in the period between t=0 and t=T.

If the problem is not the existence of a backlog of non-enrolled persons but rather that of part-time students, p_j^t should equal half the number of half-time students having age j in year t. The definitions of p_j^t can be modified if the country has both a backlog of non-enrolled persons and part-time students. Since the formal treatment does not change the meaning of the p_j^t, for the sake of simplicity we will refer only to the backlog of non-enrolled persons.

Let n_h^t denote the number of new entrants in the school system in year t having age h. It is assumed that schools must be open for all the backlog of non-enrolled persons before they reach age H+1, and during the period between t=0 and t=T; i.e., the total number of new entrants must satisfy

$$(2) \qquad P_h^0 = \sum_{j=1}^{J} n_{h+j}^{j} \qquad h=0,\ldots, H$$

with

$$J = \begin{cases} T \text{ if } T < H - h \\ H - h \text{ otherwise} \end{cases}$$

In addition, schools must be available for all persons attaining school age between t=1 and t=T. However, it will be assumed here that these persons might not begin their education at the minimum school age, but rather at some time before they reach the maximum permissible age. Let P_h^t denote the total number of persons reaching age h at year t. According to the observations above, the number of new entrants must satisfy the following conditions:

$$(3) \qquad P_0^t = \sum_{j=0}^{J} n_j^{\,t+j} \ ; \ t=1,\ldots, T$$

with

$$J = \begin{cases} H \text{ if } T-t \geq H \\ T-t \text{ otherwise} \end{cases}$$

Equations (2) and (3) refer to all the backlog and all the persons reaching school age during the periods. However, if required, they can be modified to include only a known part of either or both of these quantities.

At any time t the total number of new entrants in the educational system will be

$$(4) \qquad N_1^t = \sum_{j=0}^{H} n_j^t \qquad t=1,.....T.$$

The school facilities should make possible the attendance not only of the new entrants in the educational system, but also of all the students already in it. For this let us assume that there are G grades in the system, and denote with N_g^t the number of students in grade g year t. The values of N_g^0 for g=1,..., G will be assumed to be known. The same is value for W_g the probabilities of passing from grade g to g+1 and remaining in the educational system. It is assumed that a student cannot remain in the educational system in the same grade more than one year; i.e., the possibility of repeating a grade is excluded. From the previous observations it is possible to write the following equation:

$$(5) \qquad N_g^t = W_{g-1} \; N_{g-1}^{t-1}$$

for g=2,..., G. For g=1 N_1^t is given by equation (4).

Finally, the total number of students in the educational system in year t is

$$(6) \quad N^t = \sum_{g=1}^{G} N_g^t \qquad t=0,\ldots, T$$

The investment required to provide schools for the N^t student is

$$(7) \quad K^o + \sum_{j=1}^{t} I_j = v\, N^t \qquad t = 1,\ldots, T$$

where K^o capital available in year 0

I_j investment in year j

v capital/student ratio

The problem here is to minimize the investment required to enroll the backlog in (1) plus all those reaching school age, i.e., P_0^t t=1,..., T.

This means that

$$(8) \quad I = \sum_{j=1}^{T} I_j$$

subject to conditions 2 to 7, should be minimized.

The form of the problem in equations (2) to (8) is not suitable for use with computer programs for solving linear programming problems. The modifications required to make possible the use of computer programs are explained below with the aid of a simple numerical example. This example also illustrates how the method proposed here could bring about a considerable reduction of investment expenses.

The data to be used in the example appear in Table 1. With these data equations (2) and (3), divided by 1000 and with the meaning of the n's modified accordingly, take the following form:

$$
\begin{aligned}
(9) \qquad 81.133 &= n_1^1 + n_2^2 \\
52.229 &= n_2^1 \\
141.900 &= n_0^1 + n_1^2 + n_2^3 \\
145.170 &= n_0^2 + n_1^3 \\
148.400 &= n_0^3
\end{aligned}
$$

Table 1

DATA FOR THE NUMERICAL EXAMPLE

p_h^o		p_0^t		N_g^o		W_g	
h		t		g		g	
o	81,133	1	141,900	1	228,440	1	.90
1	52,229	2	145,170	2	119,340	2	.95
		3	148,400	3	102,102		

K^0 = 1,276,309,560

ν = 2,837

G = 3

H = 2

T = 3

From equations (4), (5), and (6), and column 4 in Table 1 we have

(1)
$$N_1^t = \sum_{j=0}^{2} n_j^t$$

$$N_2^t = .90 \quad N_1^{\ t-1}$$

$$N_3^t = .95 \quad N_2^{\ t-1}$$

$$N^t = \sum_{g=1}^{3} N_g^t$$

The next step is to eliminate constraints (4), (5) and (6) in which N_g^t and N^t appear as variables. For this, the N variables are expressed as functions of the n and the values assumed to be known. For instance, with the data in Table 1 and equations (10), it is possible to write

(11)
$$N_1^2 = \sum_{j=0}^{2} n_j^2$$

$$N_2^2 = .90 \sum_{j=0}^{2} n_j^1$$

$$N_3^2 = 195{,}316$$

$$N^2 = \sum_{j=0}^{2} n_j^2 + .90 \sum_{j=0}^{2} n_j^1 + 195{,}316$$

Once the N's are replaced by their values in terms of the n's, equations (7) divided by 1000 and with the n as defined in (9), take the following form

$$\begin{aligned} 371.3 &= 2.837 \sum_{j=0}^{2} n_j^1 - I_1 \\ (12) \quad 722.2 &= 2.553 \sum_{j=0}^{2} n_j^1 + 2.837 \sum_{j=0}^{2} n_j^2 - I_1 - I_2 \\ 1{,}276.3 &= \left(2.425 \sum_{j=0}^{2} n_j^1 + 2.553 \sum_{j=0}^{2} n_j^2 + 2.837 \sum_{j=0}^{2} n_j^3\right) - I_1 - I_2 - I_3 \end{aligned}$$

and the problem is to minimize

$$(13) \quad I = I_1 + I_2 + I_3$$

to subject to conditions (9), and (12).

The characteristics of the computer programs available forced us to take another detour and to maximize the expression in parenthesis in equations (12) instead of minimizing (13), and to obtain the values of I_j $j = 1,\ldots, 3$ as slack variables.

In Table 2, the pattern of enrollment as well as the investment required, as determined by the method described above, are compared with the conditions that would exist if the backlog problem were solved completely in year 1 and if, from then on, all school-age children were admitted to the educational system.

Table 2

ENROLLMENT AND INVESTMENT UNDER OPTIMUM CONDITIONS AND WHEN THE BACKLOG PROBLEM IS SOLVED IN YEAR 1

	Optimum Conditions	Backlog problem solved in year 1
$10^3 x\ n_1^1$	78.699	81.133
$10^3 x\ n_2^2$	2.434	0.0
$10^3 x\ n_2^1$	52.229	52.229
$10^3 x\ n_0^1$	0.0	141.900
$10^3 x\ n_1^2$	0.0	0.0
$10^3 x\ n_2^3$	141.900	0.0
$10^3 x\ n_0^2$	134.309	145.170
$10^3 x\ n_1^3$	10.861	0.0
$10^3 x\ n_0^3$	148.400	148.400
$10^6 x\ I_1$	0.0	409.475
$10^6 x\ I_2$	0.0	- 17.081
$10^6 x\ I_3$	244.690	- 182.831
$10^6 x\ I$	244.690	409.475

The pattern of enrollment in Column 2 of Table 2 is completely different from that in Column 3. In Column 2, the persons close to the maximum age for enrollment are those admitted to the educational system. The contrary is true in Column 3. The implications for investment of these two policies appear in the last row of Table 2. The negative signs for investments I_2 and I_3 in Column 3 denote over-capacity. It can be observed that the minimum total investment in the period -- Column 2 -- is only 60% of that needed to implement the policy in Column 3. This shows that the method developed in this paper has very important practical implications.

To conclude, I should like to state another problem: the optimization of the length T of the period in which the backlog problem should be solved. This problem appears because it is clear that the optimum investment determined by the method described above is a decreasing function of T. However, to increase T also means to postpone the education of a part of the population. This postponement has a social and economic cost. The economic cost, at least, can be roughly estimated. The value of T will be optimum when the marginal gain in investment is equal to the marginal cost. Conceptually, the problem is not difficult. To the person attempting to find a numerical solution, I can only wish "good luck".

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The author wishes to thank Professor M. Sherba and Mr. R. McMeekin for their collaboration in the computation of the numerical example included in this paper. Any errors that remain are the author's responsibility.

Problems of Educational Planning in Developing Countries

Nicholas DeWitt

I am happy to be with you today because it gives me a chance to greet old friends as well as a chance to tell you about my current research, which is supported largely from Carnegie Corporation and Ford Foundation grants. In the last three years I have spent a great deal of time overseas studying economic and manpower planning activities and looking at educational conditions in the developing countries of Asia and Africa as part of the project International Survey of Educational Development and Planning. I have visited some 50 countries reviewing their educational and manpower planning activities. In the next couple of years a set of books and monographs will present the relevant findings of this survey.[1]

My presentation today is not aimed at summarizing all of the results. Rather, let me pass on some of my general observations. As one looks at the underdeveloped countries, they may seem to be one entity. But once one gets there, they are many entities--

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[1] See selected references at the end of this paper

economically, politically and culturally disjointed.

Comprehensive Human Resource Development Planning

In recent years voluminous literature has emerged on the subject of "educational planning." A sharp distinction must be drawn between what is meant by human resource development planning and educational planning. Educational planning is concerned with indigenous factors of programming educational activities without necessarily being concerned with the exogenous factors of manpower utilization. Consequently, the sources of demand for education--whether private or social--are assumed by the educational planners as given by the national plan for human resource development.

Educational planning is concerned with how this demand is to be satisfied. Human resource development planning, however, is concerned with demand function proper--projections of nationwide requirements for both short- and long-run periods for educated manpower. Thus, the backbone of human resource development planning is manpower planning. The human resource development plan makes decisions--how many youths with what kind of education are needed to enter gainful employment in industry sectors, states, occupations, types of enterprises, and so on. The educational plan elaborates measures for the implementation of this decision--the translation of the existing relationships (size of enrollments, schools and classes, pupil-teacher ratios, curricular contents, and so on) into instructional and budgetary requirements. In most developing countries some work is being done on the latter, but the former activity is either downgraded or simply neglected.

In most developing countries as well there is perhaps some over-enthusiasm about education and its potential. Great things are expected of education. Granted, education is undoubtedly an indispensable prerequisite for development and change, by itself it does not account for nor does it constitute "development." If a realistic assessment of the education potential is to be made, it must be emphatically stated that education, as the main source of supply for the desired manpower needed for development, is a tool rather than an end in itself. Underdeveloped countries balk at this principle.

If human resource development planning is to become an integral part of the economic and social development plan, the functional nature of education must be recognized. The principal aim of national planning for human resource development will thus become to provide guidelines for the educational system to follow in producing the needed complement of trained manpower in response to economic and social needs. It is precisely in this area--the assessment and planning of the derived demand for education and training on the basis of the manpower plan related to economic and social development targets--that the planning exercises and the enforcement of priorities in implementing targets fall far short of their potential in most developing countries.

In the past decade many writers have asserted that the development of a national system of education makes possible rapid economic, social and political advances. There is a presumed causal relationship between the two. While the educational opportunities in developing countries have multiplied many-fold,--three- to five-fold increases in enrollments over the last 15 years are not uncommon--there have been neither impressive rates of economic growth nor political stability. Many developing countries already spend up to a third of their national budgets on education. The resources are lavishly wasted on ineffective and inefficient primary education, while the bottleneck types of occupational training programs are starved. Education has become a bottomless pit, the insatiable demands of which neither poor developing countries nor their rich overseas benefactors can fully meet. Most of the present problems arise from the fact that economic change has not been as spectacular as the political and social transformation caused by independence would indicate. Therefore there continues to exist a serious disparity between the pace of economic growth and the growth of expectations. Expanding education was like adding fat to the fire--it fired and continues to fire more expectations while the real resources simply do not exist to satisfy them.

Educational Planning--An Adjunct of the National Plan

There is a widespread belief that economic progress and education are closely related. In developing countries this proposition is not viewed as a working hypothesis, but as a universal myth. Among contemporary international and national modernizers it is held that a great and universal demand exists for more and better modern education. This is more an item of faith than reality. It is more a response to political slogans than to actual need. The global plans for education such as the Karachi plan for Asia and the Addis Ababa plan for Africa, and scores of national plans which often gear their policies and political slogans to these global targets, simply overlook the existing supply-demand relationships. The crucial and unanswered questions of "What is meant by education?" and "Education for what?" are simply avoided.

All countries studied conduct some sort of activity commonly called "educational planning." In almost every country the Ministry or Department of Education has an official or group of officials or structural unit which deals with "educational planning." UNESCO has a research and training center in Dakar for educational planning in Africa. It has a planning center in Beirut, in Bangkok, in Santiago, and scores of national centers and educational planning advisors. All of this appears impressive in theory, but all it amounts to, in actuality, is most inefficient activity. Educational planning officers or units perform two tasks. On the one hand, they try to improve statistical information about schools, enrollments, teachers, and so on, all of which deal with intra-educational problems of primary and secondary schooling. On the other hand, they produce so-called "educational plans"--there are several dozen of these--which extrapolate from existing and often unreliable demographic data and assumed attendance and success rates of students what future enrollments will be and then, applying unit costs (per-pupil, per-teacher or per-school), try to "cost-out" what future expenditures on education should be.

Africa--Example of Global Targets for Education

Let us take Africa as an example. There are two political documents which overshadow all of these planning efforts--the famous Addis Ababa (1961) and Tananarive (1962) conference goals. These ambitious goals, agreed upon by most education ministries of Africa, proclaim that by 1980:

(1) there should be universal, compulsory and free primary education;

(2) 30 per cent of primary-school graduates should continue secondary education with one-third in academic and two-thirds in vocational schools; and

(3) 20 per cent of secondary-school graduates should continue in higher education, of which not less than 60 per cent should study in scientific and professional fields (sciences, engineering, medicine, and agriculture).

My experience has been that individual countries refer to these goals only when it is in their interest or convenience to do so.

Many educational planning offices prepare specific plans for each segment of the educational system, not as a measure of their own ambitions, but scaling them down to the realities of the situation. However, when it comes to making these plans public, the grandiose and politically motivated targets are released and the actual "feasibility" targets are passed from the top drawer of the Ministry of Education into the files of the treasury. I am happy to report that on the basis of the latter, at least six countries have now decreed a "readjustment period," or simply a freeze on the further expansion of primary education.

Obviously, the implementation of educational plans varies from country to country, but my impression is that most African countries are well ahead of target as far as elementary education is concerned. Many countries already have one-half to three-fourths of the pertinent age group in primary schools. There are some regions, however (like Northern Nigeria--30 per cent), or rural areas (as in Ethiopia--only 6 per cent), where primary school enrollment is still very low.

But the real problems are the deterioration of the quality of primary education (after grade 2 or 3 almost two-thirds of the pupils become dropouts) and the lag in attaining targets on the secondary and tertiary levels of education. In most African countries the secondary schools absorb still far less than 2 per cent of the age group, and all institutions of higher education (both of the degree and diploma type) enroll less than _one-tenth of one per cent_ of the relevant age group. I am suggesting that during this decade as a result of so-called "educational planning", most African countries have succeeded in creating an army of unemployed (and unemployable) school-leavers, the majority with only partial primary education, but that at the same time the educational opportunities which produce medium- and high-level manpower have not expanded sufficiently.

Manpower Planning--a Sparse Activity

Both individuals and government agencies in all the underdeveloped countries visited are aware of the potential value of manpower planning and the assessment of manpower needs. However, only limited progress has been made to include manpower assessments in national development plans. In Africa, the most active manpower planning units are in Tanzania and Nigeria. All these activities are supported in part by the Ford Foundation. National manpower boards are set up in many countries in the ministries of economic development or planning, with broad powers to coordinate the work of other ministries. Recent manpower surveys have been completed for Zambia and the Sudan, but no permanently functioning manpower directorate exists in these countries. Partial (and old) surveys have been made for Guinea, Liberia, Ghana, Ethiopia and Uganda, but again there are no continuing activities in manpower planning in these countries. Manpower surveys are in progress in Kenya and Malawi; and the Harvard Advisory Group is attempting one for Liberia. In view of the disintegration of Nigeria, northern and western regions are trying to set up separate regional manpower directorates. Ghana will probably revive its manpower directorate which--strangely enough--discontinued functioning under Nkrumah. We should add to this list the United Arab Republic, which has had a functioning (I won't say how well) Manpower Mobilization Office since 1954, and Tunisia, which has a manpower office and has conducted several surveys. All of these activities add up to a rather spotty picture.

All manpower surveys--past, present or contemplated--utilize essentially the same technique; namely, the use of establishment survey questionnaires which deal with employment by occupation, grouped into different levels of skills--low, medium or high, and then attempt to relate these data to actual or assumed coefficients of educational attainment. The major preoccupation in most surveys is with high-level manpower because it indeed constitutes the major problem. The shortage of highly trained and experienced managerial, administrative and professional personnel presents a major dilemma for all African governments. On the one hand, they are anxious to "Africanize" as rapidly as possible and, on the other, they recognize that economic development, and particularly adaptation of technology from abroad, increases rather than diminishes the need for experienced expatriate personnel. In the meantime, the output of university trained professional personnel is highly inadequate, and prospects for increased output are poor.

High-Level Manpower and African Universities

Problems of university development, particularly as they relate to the training of professional manpower, are my favorite areas of research. University expansion in Africa has been most impressive, despite the fact that, in my judgment, resource allocation to this level of education has not been sufficiently generous. There have been many efforts to plan university development in Africa on a cooperative basis. I think these were noble, but mostly futile exercises in rationality. Currently in tropical Africa some 30 new institutions of higher learning have recently been established or are on the drawing boards. The cost of creating each of these institutions is staggering indeed, but the political realities are such that national and regional ambitions have resulted in the establishment of even more universities in Africa than were anticipated only a few years ago. This proliferation will no doubt continue.

University enrollments in tropical Africa have almost tripled in the last ten years. Much as I wish to see the humanities and the social sciences flourish in Africa, I am shocked to observe their total irrelevance to Africa's development needs. The proportion of students enrolled in the natural sciences, engineering, agriculture and medicine has remained basically unchanged in the last ten years. Only about one-quarter (instead of a global target of 60 per cent) are studying in these professional fields. Annual output is about 400 to 600 graduates--and this is for a population of some 180 million. My preliminary estimates indicate that there are currently about 20,000 persons with higher education in the natural sciences, engineering, agriculture and medicine in all of tropical Africa. About four-fifths of these are expatriates, which leaves only 4,000 native Africans with a scientific or professional education. Current output just barely covers annual losses. To say that scientific and professional manpower is in "short supply" is a marvelous understatement. I believe that the development of scientific and technical education should be made not just a priority, but the only priority for which international assistance for education in Africa should be made available.

One of the fundamental problems of development is the process of adaptation--adaptation of education, technology and experience to the specific development needs of a given country. If Africans want to Africanize their economies and adapt modern techniques to their agricultural and industrial development needs, they must first have native Africans to do the job. The technological and managerial elites in Africa are still composed largely of expatriates and if Africa is ever to become a "bright" continent, it would need many native doers. However, it appears to me that very few Africans aspire to become such. Why?

Partaking in European education, regardless of its content and practical utility for a country's needs or performance of the individual's productive functions, became a technique of social advancement in Africa. The "colonialists" should not be blamed for the motivations of the natives to seek education in the humanities rather than in the sciences as a means of advancement and prestige. The distinguishing mark of the native elites in Africa is adaptation of the "European" mode of life. The proliferated corps of bureaucrats is recruited on a competitive basis, and all the prospective candidates seek education which qualifies them for offices and white-collar jobs in the most expeditious manner.

In the competition for entry into government service (which in most African countries comprises well over half of all salaried jobs), education in the humanities, arts and law is more valuable than preparation in science or technology. There is a platonic ideal transferred to Africa by Europeans, that educated leaders must be versatile generalists and that development and change permeate from the elite to the masses. Many utterances by new African leaders about democracy, equality, national integration, and so on, are in sharp contrast with their actual practice--elitist political and social patterns of behavior. Professional graduates are thought of as artisans, engineers as lowly "narrow" technicians, and technological and vocational education as a pass only towards the unglamorous, undesirable and unrewarding jobs. With such attitudinal patterns, education becomes essentially a tool for the creation of elites, and not the means for developing productive pursuits and differentiated and specialized skills needed for economic development. All of this makes me wonder--"Is formalistic education in today's Africa actually irrelevant for development?"

India--Missing Priorities

Let us take India as another example. Again we have a global plan--Karachi targets for universal primary education, expansion of secondary schooling and so on. But let us look at reality. First, it should be noted that India is already a labor-surplus economy, due partly to economic underdevelopment and, in large measure, to the high rate of population growth. Thus a "chronic" situation of under-employment or unemployment is built within the economy. This is particularly true of the rural areas and agricultural sectors. Employment opportunities created during the last ten years fell short of the original targets. Although during the last three Plans millions of new jobs were created, the expansion of employment was not sufficient to absorb new entrants to the labor force. The volume of unemployment has been increasing from Plan to Plan. Unemployment increased from 5.3 million at the end of the Second Plan to 12 million at the end of the Third. During the next ten years, while the total labor force will increase by some 77 million, the number of workers is expected to increase by only 23 million and by another 30 million in the following decade. India must make a supreme effort in economic development if jobs are to be created for some 50 to 70 million people in the next 20 years.

But while India is and most likely will continue to be a labor-surplus economy, it invariably experiences an acute shortage of highly trained personnel and above all, a lack of broadly educated workers who could contribute to improvement in productivity in India's agriculture and industry. So there is a dichotomy. On the one hand, there is a glut of untrained and illiterate workers and on the other, a relative scarcity of well-educated skilled workers and specialized personnel.

Over one-half of the urban and over four-fifths of the rural workers are totally illiterate. Only one-fifth of urban and 7 per cent of rural workers have been educated beyond basic primary school. The implications of these current figures for setting educational policy are obvious: (1) unless India succeeds in providing effective primary education, it will not be able to solve the problem of literacy during this century; and (2) unless India expands educational opportunities on the secondary level and beyond, it will not be able to satisfy its skilled and high-level manpower needs for decades to come.

However imperfect present manpower statistics for India are, the pyramid of high-level manpower is very much distorted by the presence of "generalists." as clearly indicated by the following 1961 data:

Total population	440,000,000
Labor force in prime working age groups (10-59)	287,000,000
Literates (with any level of education)	93,000,000
Persons with elementary education and beyond	51,000,000
Matriculates and beyond	8,200,000
Degree- and diploma-holders from higher education	1,100,000
Among these, persons with specialized higher education in scientific fields	220,000

The trained manpower pyramid in India was not only "narrow", with only 2 per cent educated to the secondary and higher level, but also lop-sided, with only about one-fifth of all high-level manpower degree and diploma holders trained in specialized fields--science, engineering, medicine, or agriculture.

At the anticipated rates of educational output, by 1981 there will be three times more persons (about 150 million) with elementary education and beyond, 2 1/2 times more matrics (about 25 million) and about 3 times more higher education graduates (about 3.5 million). Quantitatively, this would be a significant improvement. However, unless measures are adopted to reorient secondary and higher education along specialized lines in the late 1960's, the product-mix of high-level manpower will not change in the next 15 years. In my judgment, in the 1970's India will need 50 to 60 per cent of its annual flow of secondary and higher education graduates (and diploma-holders) in specialized fields, as compared with the present 20 per cent on the higher education level and less than 5 per cent on the secondary level.

It is in this context of the modernization and reorientation of education that the National Education Commission of India recommended last year a stress upon: (1) science as a basic component of all education and culture; (2) work-experience as a tool which teaches people how to work and to love work; and (3) qualitative improvement of scientific and technological education as a key to agricultural and industrial development. These are the ultimate goals which I feel have been correctly identified for the national development of India.

If we assume these to be reasonable targets, the problems involved in implementing them are vexing indeed. At the root of the problem is the pluralism of India's political system namely the federal states versus the center controversy and the relative autonomy of the state education ministries or departments and, particularly, the great autonomy of universities vis-a-vis both the center and the states. Under these circumstances, no matter what kind of structural change in the school system is proposed and no matter what kind of curricular revision is suggested, their implementation rests not with the center's Ministry of Education or the Planning Commission or other ministries, but with state agencies and individual institutions. Commissions write proposals, and the politicians dispose of them. Just as in most African countries, in India also the political instrumentality to implement rational educational output targets is simply lacking.

Utility of Manpower Planning Models

In using the manpower approach to educational planning, there are basically three models: statistical, econometric and impressionistic-judgmental. The first deals with forecasts of derived demand for education on the basis of extrapolation from current, past and projected education-occupation-employment requirements. The second model deals with projected demand for trained manpower (stocks and flows of education outputs) on the basis of the interrelations of labor inputs with other factor inputs and outputs, such as growth and distribution of income, capital, investment, changing productivity, etc. Finally, the third "model" is the impressionistic-judgmental attitude towards career opportunities and occupational choices, which in many diverse ways motivate people to select the education of their own choosing. In its broadest sense, the latter model incorporates the diversity of judgments, market forces, mobility guidelines and cultural attitudes which affect both training and employment choices. It is an intelligent guess as to what educational output will be available and could be absorbed by society.

The aforementioned ideal types for study and research should be substantially qualified for reasons of expediency. Educational planning in general and the planning of manpower in particular under any circumstances is not a science or an exact discipline. It is an art, and the only issue is now "rational" or "analytical" or pseudo-"scientific" this art is to be. It has to be kept in mind that the forecasting of an education-occupation-employment matrix can serve many useful purposes even if it is only "approximately right," rather than perfectly correct. Many if not most statistical or econometric models give no better results than the judgmental-impressionistic model. Therefore while scholarly purity ought to be the aim in theoretical research, the results which could be expected from such refined studies may not be of any greater value to the policy-maker than less refined "quick and dirty" target-setting. This is particularly true for developing countries, which must make decisions without adequate data and often even without any facts.

What are the lessons from the two examples--India and Africa? Quick and dirty target--better than 1/2 of the educational output should be employment-oriented with emphasis on scientific and professional fields. But how to prepare and enforce such a plan target is a thorny issue.

The time schedule available for preparing an elaborate "plan" has a great deal of impact not only upon its thoroughness but its usefulness for implementation. Gestation periods for plans which reflect the work of professional economists and other social scientists, particularly in reference to developing "new data," balancing criteria and theoretical soundness, are exceedingly long. In many instances the professional's plan must be scrutinized further and put through an entire panoply of "popular planning," i.e., legislative review, hearings, witnesses, laws, etc.--all of which delay the "action plan" urgently needed for political decisions. There is a radical difference between "quick and dirty" target-setting and action scheduling and scholarly planning. Many plans of developing countries are exercises in scholasticism rather than realistic decision-making. If the purpose of a theoretical study is to gain thorough professional knowledge of the situation and make long-range prognosis for policy, then the time schedule could be longer. Otherwise, "quick and dirty" target setting should be the sole guide for most underdeveloped countries.

Conclusions

I have selected these two examples--Africa and India--to sketch how the manpower approach could aid in policy-making and decision-making for educational planning. You may have detected my bias from the very beginning--I do not believe that educational planning can exist in isolation from other types of planning, particularly manpower planning. In order to analyze the strategy for human resource development, an examination of the economic, social and political forces in a society is perhaps more crucial than knowledge of a formal system of organized education. Educational planning which deals with education per se is of little value in making decisions as to what the goals of education should be. Except for an analysis dealing with the efficiency of the learning processes and scheduling instructional activities, the tools for assessing human resource development lie outside the realm of formal education as such. Human resource development and "human capital" formation may start with some formal education, but they are not limited to it and are never localized there. The parameters of human resource development are more complex. Formal education does not and should not shape but must itself be shaped to suit development needs.

In the developing countries there is a general awareness of this problem, but due to the interaction of multiple political and social factors, there is inability, or even unwillingness, to enforce this principle. Therefore educational planning is used not as a rationing device, but as a tool for the justification of further proliferation of inappropriate types of education. How to foster and to implement decisions for making education relevant to development needs remains the real and perhaps insoluble dilemma of planning in most of the developing countries of the world.

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On the Development of Educational Planning Models at Harvard, CSED: An Algebraic History of Activity in One Small Place

Russell G. Davis

On History

This paper is a history of work on educational planning models at the Center for Studies in Education and Development, Harvard University. Histories are not usually written in algebra, although some sections of this paper will be. Still, we shall hold mathematical symbols to a minimum, and try to be as wordy as we can, given the subject. The history is limited to activities at CSED. Educational planning models have been developed in other times and places, but we shall not mention them because all we know about them is what appeared in the papers, and one of the present themes is that it is possible to learn more from the history of minor events which feature mixed success and failure. Once the matter gets glossed up for publication, it is difficult to learn more about it than a clever researcher or writer wishes to give away. More can be learned from a rude history of flawed work and that is what this is. But in this history the one fatal flaw is avoided--in every case the models represent work in process. The work is perceived as incomplete. As this history is being written the models are being dismantled and re-assembled and, hopefully, improved. Statements made in this paper are being turned into obsolescence by the researcher's restless quest for improvement.

Failure One

The author should take credit for the first and worst of the models to be examined. This model should be called Failure I. In the early sixties the author was interested in applying the activity analysis format of linear programming to resource allocation within an educational system, and the basic structure of the model used was this:

Model I

Optimize: $C_1X_1 + C_2X_2 + C_3X_3 + \ldots + C_nX_n$

Given $X_1 \geq 0, X_2 \geq 0, \ldots X_n \geq 0$

And $a_{11}X_1 + a_{12}X_2 + \ldots + a_{1n}X_n \leq b_1$

$$a_{21}X_1 + a_{22}X_2 + \ldots + a_{2n}X_n \leq b_2$$

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$$a_{m1}X_1 + a_{m2}X_2 + \ldots + a_{mn}X_n \leq b_m$$

Symbolically, the Situation in Model I was:

$X_j = X_1 \ldots\ldots X_n$	Number completing various educational programs or levels (e.g., primary through university)
$C_j = C_1 \ldots\ldots C_n$	Some magnitude reflecting the utility, income or rate of return on persons educated to this level
$a_{ij} = a_{11} \ldots\ldots a_{mn}$	Amount of resource i necessary to produce a graduate of level j under assumptions about minimal standards (teacher-pupil ratio, allocation and unit cost for textbooks, physical plant, equipment...)
$b_i = b_1 \ldots\ldots b_m$	Resources available for education (money available for plant, equipment, books...trained teachers...)

The limitations of Model I are legion, but it is worth mentioning only a few. First, there is the assumption of linearity, which badly reflects educational technology in the constraint equations or how education pays off in the objective function. Originally, the model was set for a single period, values being aggregated over the time necessary to produce a graduate in each level. (Wastage and retardation could be taken care of either in the technological coefficients or by using wastage coefficients in the objective function.) The results of such a static and unreal aggregation could only be unbelievably crude; as indeed they were on the examples that were run. In its original form the model was not varied parametrically and there was no sensitivity analysis performed. The use of fixed input coefficients is dubious indeed, and the notion that educational technology would remain unchanged over the period of time necessary to produce graduates within levels is grotesque. The objective function, with discounted net earning streams used as weighting coefficients, has problems which need not detain us here, because they are more appropriately the concern of the economist, rather than the educational planner. In general, however, attributing earning differences to educational level attained is a doubtful proposition, and assuming that differences will hold in the developing countries where this model was supposed to be applied is even more unreal.

There also is the problem of where the resource vector came from at the outset. If the planner knew this much about the future, he would not require such a crude model in the first place. The model, of course, only permits allocation within the sector of education, and assumes that the total resources for the sector and the resources in each category are already known and fixed. There are a host of other weaknesses, some of which will be discussed in later development.

Failure Two

Model II was developed to program the output of educational and training activities to meet the requirements of the work force insofar as these requirements could be expressed in education and training attainment terms.

In its static form:

Model II

Optimize $C_1X_1 + C_2X_2 + \ldots + C_nX_n$

Given All $X_j \geq 0$

And $a_{11}X_1 + a_{12}X_2 + \ldots + a_{1n}X_n \geq Y_1$

$a_{21}X_1 + a_{22}X_2 + \ldots + a_{2n}X_n \geq Y_2$

.

.

.

$a_{m1}X_1 + a_{m2}X_2 + \ldots + a_{mn}X_n \geq Y_m$

Y_i = work force requirements expressed in educational attainment terms

a_{ij}= flow or transition coefficients

This model had most of the problems of the first one, plus a few new defects. In the first attempt with the model, the matrix turned out square and the solution deterministic, and the basic feasible solution was the optimal one. There was also the problem of a static model requiring aggregation over a lengthy time period (the time necessary to complete an education or training level and join the work force) and to get around this a dynamic structure was counterfeited in Model III.

MODEL III

Dynamic Structuring of Flow Model

x_1^1	x_2^1	x_3^1	x_1^2	x_2^2	x_3^2	x_1^3	x_2^3	x_3^3		
+1										$= x_1^0$
	+1									$= x_2^0$
		+1								$= x_3^0$
a_{11}	a_{21}	a_{31}	-1							$= y_1^1$
a_{12}	a_{22}	a_{32}		-1						$= y_2^1$
a_{13}	a_{23}	a_{33}			-1					$= y_3^1$
			a_{11}	a_{21}	a_{31}	-1				$= y_1^2$
			a_{12}	a_{22}	a_{32}		-1			$= y_2^2$
			a_{13}	a_{23}	a_{33}			-1		$= y_3^2$
						a_{11}	a_{21}	a_{31}	-1	$= y_1^k$
						a_{12}	a_{22}	a_{32}	-1	$= y_2^k$
						a_{13}	a_{23}	a_{33}	-1	$= y_3^k$

TABLE 1 (For explanation see page 49)

Table 1. Dynamic Structuring of a Single Transition Matrix. x_i^0 is the number of persons enrolled in class level i during the initial period.
y_i^0 the needed additions to labor force from class i at the beginning of period j, j = 1, 2,..., k; and x_i^j the enrollment in class i at the beginning of period j. The a's are the transition matrix. The example is for three class levels.

Model III had most of the weaknesses of the previous models. The assumption of linearity persisted. The aggregates and the lack of sensitivity testing made for crude results. The costs used in the objective function were based on sounder estimates than the net earning differences in Model I, but there were underlying weaknesses. The a_{ij} coefficients which represent flow through the system into the work force make Model III appear to be dynamic. But this is deceptive. The flow coefficients were kept invariant over the several periods, even though every indication is that they would not hold over this period. This could be remedied by shifting the coefficients each period, but there was no basis in the model or in other data to guide such a shift. The model was dynamic in appearance only.

Better Models

During this same period Bowles (1965) developed models which were more adequate than those previously described, but which still fall short of providing a basis for practical decisions in educational planning. Since the Bowles' work is available elsewhere and space is limited, it is better to go on to further developments by Schiefelbein which were slightly more ambitious in theoretical scope and much more adequate numerically.

Schiefelbein's intent was to develop a multiperiod linear programming model to study decisions on the allocation of resources within education in Chile. Influences outside of education were assumed to be constant or determined exogenously. In Schiefelbein's model the present value of a cost function (expenses of operating the education and training systems) was minimized subject to certain constraints. The model, as did the previous ones, sought to find the most efficient way of meeting a set of requirements, i.e., labor demand expressed in education and training attainment levels fixed exogenously.

Schiefelbein's Model

1.-Equations

Minimize: $C = \Sigma_t c_t$ (1)

$$c_t = \alpha_{1t}\cdot z_t + \alpha_{2t}\cdot y_t + \delta_{1t}\cdot v_t + \delta_{2t}\cdot u_t + \varepsilon_{1t}\cdot w_t \tag{2}$$

$$c_t \leq \hat{c}_t \tag{3}$$

$$X_t \cdot \lambda_n \leq \Pi_t \tag{4}$$

$$X'_t \cdot \lambda_a = z_t \tag{5}$$

$$\Phi_{1t}\cdot z_t - \sum_{s=1}^{t-1} \Omega_{gs}\cdot z_s - \sum_{s=1}^{t-1} u_s + \sum_{s=1}^{t-1} \Lambda \cdot u_s \leq u_o \tag{6}$$

$$\Phi_{2t}\cdot z_t - \sum_{s=1}^{t-1} v_s \leq v_o \tag{7}$$

$$\Omega_{t-1}\cdot z_{t-1} + y_{t-1} = z_t \tag{8}$$

$$y_t \leq H_t \cdot z_{t-1} \tag{9}$$

$$M_t \cdot Z_t \cdot z_t + w_t - \Lambda \cdot w_t + u_t - \Lambda \cdot u_t \geq \Psi_{t+1} \tag{10}$$

$$w_t \geq \bar{w}_t \tag{11}$$

$$w_t \leq \hat{w}_t \tag{12}$$

$$x_{ijt} \geq x_{ij,t-1} \tag{13}$$

$$x_{ijt} \geq \bar{x}_{ijt} \tag{14}$$

$$X_t \cdot \lambda_n \geq P_t \cdot \Pi_t \tag{15}$$

2. Variables

z = column vector, (nxl) of z_j activity levels. Each activity represents the number of students in educational level j.

y = column vector, (nxl), of y_j activity levels. Each activity level represents the number of students promoted to level j over the historical trend. The level of activity of these variables show the increment with respect to the number of students usually promoted to grade j required to meet the set of constraints.

X = matrix, (axn), of x_{ij} activity levels. Each activity level represents the number of students of age i in educational level j in the period.

$\bar{x}_{ijt}$ = estimated number of students of age i in grade j in period t.

w = column vector, (nxl), of w_j activity levels. Each activity level represents the number of workers on-the-job trained for level j in the period.

w_o= column vector, (nxl), of w_{oj} coefficients. Each coefficient represents the initial stock of workers in level j.

v = column vector, (nxl), of v_j activity levels. Each activity level represents the number of m^2 built in the period for the educational level j.

u = column vector, (nxl), of u_j activity level represents the number of teachers on-the-job trained required for educational level j in addition to those teachers trained in the formal educational system.

C = operation expenses of all levels in the educational system during t periods under the below stated set of constraints. The expenses include current costs and the investment required to add new capacity to the system.

c_t = cost of operating the educational system in year t under the set of constraints for all the periods.

$\hat{c}_t$ = maximum amount of resources the educational system can expend in year t.

3. Parameters

α_1 = row vector, $(1xn)$, of α_{1j} coefficients. Each coefficient represents the annual current costs per student in level j.

α_2 = row vector, $(1xn)$, of α_{2j} coefficients. Each coefficient represents the monetary annual costs per additional students (above historical trend) in level j. This vector denotes the costs of introducing improvements in the system in order to get a higher rate of promotion in the corresponding level.

β = percentage of GNP devoted to education.

δ_1 = row vector, $(1xn)$, of δ_{1j} coefficients. Each coefficient represents the costs per m^2 built in the period in level j.

δ_2 = row vector, (1xn), of δ_{2j} coefficients. Each coefficient represents the annual costs per teacher on-the-job trained for level j.

ε_1 = row vector, (1xn), of ε_{1j} coefficients. Each coefficient represents the annual costs per worker on-the-job trained for level j.

Z = diagonal matrix (nxn), of the ζ_j drop out rates of the j level of the educational system.

H = diagonal matrix, (nxn), of η_j coefficients. Each coefficient represents the maximum improvement on promotions from level j.

ι = annual rate of depreciation of the buildings stock for each one of the different sources of the stock. If the rates of depreciation are functions of the age distribution of each sources they can also change over time.

Λ = matrix, (nxn), with 1's in the diagonal above the main one and zeros elsewhere. The product of this matrix and a column vector has the j element being the j+1 element of the previous vector. The last element of the new vector is zero.

λ_n = column vector, (nx1), of unitary elements = $(1, 1, \overset{n}{\ldots}, 1, 1)'$

λ_a = column vector, (ax1), of (identical) unitary elements

M = diagonal matrix (nxn) of the μ_j proportions of the total leavers of the educational level joining the labor force.

M_1 = diagonal matrix, (nxn), of μ_{1j} coefficients. Each coefficient represents the proportion of the total number of graduates going to teach in educational level j.

V = annual rate of retirement of the teaching force over the planning period for each one of the different sources of the stock of teachers. If the rates of retirement are functions of the age composition of each group they can change over time.

Π = column vector, (ax1), of Π_i values. Each value indicates the number of children in age group i in the period.

P = diagonal matrix (nxn), of the ρ_j coefficients. Each coefficient represents the minimum percentage of the population that must attend school in the period.

Φ_1 = diagonal matrix, (nxn), of Φ_{1j} coefficients. Each coefficient represents the number of teachers per student in educational level j. Each coefficient therefore, corresponds to the reciprocal of the students-teacher ratio.

Φ_2 = diagonal matrix, (nxn), of Φ_{2j} coefficients. Each coefficient represents the number of m^2 per student in educational level j. Expressed in terms of the space of the standard classrooms the coefficient, therefore, corresponds to the reciprocal of the students-classroom ratio.

Ψ = column vector, (nxl), of Ψ_j coefficient. Each coefficient represents the required number of workers with educational level j in the period.

Ω = matrix (nxn), of transition ratios (probabilities). The w_{jj} elements of the matrix are the repetition ratios for the level j and the $w_{j+1,\ j}$ elements correspond to the promotion ratios from level j to the level j+1. (The drop-out and graduate ratios from each level leaving the system are included in equation 10. Part of them are also included in equation 6).

Ω_g = diagonal matrix, (nxn), of w_{gj} coefficients. Each coefficient represents the graduation rate for teachers going to teach in educational level j. Most of these coefficients are usually going to be zeros.

Ω_i = matrix, (nxn), of transition ratios of the age i student population.

$\bar{w}_t$ = column vector, (nxl), of $\bar{w}_j$ coefficients. Each coefficient represents the minimum number of workers it is necessary to train in the period in order to maintain an adequate capacity for training workers.

$\hat{W}$ = column vector, (nxl) of $\hat{w}_j$ coefficients. Each coefficient represents the maximum number of workers it is necessary to train in the period in order to maintain an adequate capacity for training workers.

4. Indices

t = time index of the period. The unit used is one year.

j = educational levels.

i = age groups.

Despite the size and complexity of the model it suffers from the limitations of the previous ones. The description of the educational system was still crude. Computer costs forced Schiefelbein to limit the description of the system to the barest quantitative minimum: six aggregate educational levels; six age groups; two types of teachers; three kinds of buildings; two kinds of on-the-job training; and five levels of manpower requirement. He could use only three time periods. Even this much produced a formidable array of 230 variables, 160 equations and 760 matrix entries. Results were still crude, though a great deal less crude than in the earlier linear models. Though less static, the Schiefelbein model still had to lump time periods to save computing time. The model did not escape limitations imposed on it by the assumption of linearity and the parametric variations did not avoid rigidities introduced by fixing certain coefficients beforehand. Educational demand in the work force was taken as a given, supplied from outside the system. The model allowed for no substitutions between the number and level of skills for workers.

In his accompanying analysis, Schiefelbein faced up to almost all of these limitations and attempted to cope with them. He did this in several ways:

1. By frank assessment of the limitations of data and model and perceptive criticism of the results.

2. By offering cautions on the use and interpretation of the model and its results. Schiefelbein tried to use optimizing techniques as criteria for testing and selecting possible results. He viewed each optimizing run as a trial in a larger context of simulation. The notion was that to a set of data and relationships the planner could link certain assumptions. The combinations of data, relationships and assumptions could be used to simulate possible future states of the system. The model then, within the constraints and according to the optimizing criteria, would provide a set of answers for any given combination of data, relationships and assumptions. With different assumptions different answers could be simulated. Schiefelbein stressed that the results were built into the model from the outset and that optimizing techniques did not provide a substitute for other necessary kinds of empirical analysis.

The results, largely provided by parametric variation and sensitivity analysis, were appropriately qualified. The study closed with suggestions for more adequate models to get around the basic limitation which the assumption of a linear form imposed.

The sensitivity analysis did provide some useful but not startingly important results. On-the-job training appeared to cost much more than formal education, but such high-cost training was necessary in situations where short-run manpower gaps could only be filled through informal means. The break-even points for formal and informal education in Chile were shown fairly clearly. Optimal enrollment paths and patterns of intervening years were also shown. The model suggested ways for comparing investment decisions through discounted differences in costs, but the numerical results did not give any such comparisons. In general, many analysis and decision possibilities were suggested but not fully explored in numerical analysis. In some cases these decisions would be interesting and important to a planner. In other cases the results had theoretical significance primarily to an economist, e.g., numerical values of shadow prices in the dual solution.

The model did not handle certain political problems in educational planning. It was confined to problems of quantity rather than quality. Even when the author discussed ways to study quality he was talking about difference in quality of inputs, rather than the problems of measuring qualitative differences in educational output. Even if the model were expanded to account for differences in quality (e.g., more highly trained teachers, use of special services, equipment, etc.) this expansion refers to the input side, and not to the output side where one trained or educated head is counted as equal to another. It is apparent that certain of the input of components are non-linear or will become so when followed over time. For this reason, the linear programming model no matter how large and disaggregated it becomes, will provide only partially satisfactory answers to the planner.

Beyond the Linear Models

Quadratic Programming

Advances beyond linear models have been largely theoretical, and as yet there has been no extensive computational experience at CSED. Schiefelbein has set out to examine the possibility of developing quadratic program models that could be useful for simulating the effect of changes in quality on changes in the quantitative variables. The problem would be to minimize a quadratic function of non-negative variables subject to linear constraints. There could be an approach through an objective function which is envisaged as appearing:

$$\text{Min. } C = \Sigma_t X_t' A_t Z_t + v' \Delta_t v_t + q' E_t q_t$$

where: t = time index of the period. The unit used is one year.

A = diagonal matrix (nxn) of α_i sets of current costs of educational level i coefficients.

α_i = row vector (1xm) of α_{ji} current cost of input j in educational level i coefficient. In fact α_i can also be considered as a sub-matrix of the partitioned matrix A.

x = column vector (nx1) of x_i sets of inputs per student enrolled in educational level i activity levels.

x_i = column vector (mx1) of x_{ji} input j per student enrolled in educational level i activity levels.

z = column vector (nx1) of z_i number of students in educational level i activity levels.

v = column vector (nx1) of v_i sets of investment in educational level i activity levels.

v_i = column vector (kx1) of v_{hi} investment of input h in educational level i activity levels.

Δ = diagonal matrix (nxm) of Δ_i sets of investment costs of educational level i coefficients.

Δ_i = diagonal matrix (hxh) of δ_{ji} investment costs of input h in educational level i coefficients.

q = column vector (nx1) of q_i increments of education of workers in level i activity levels.

E = diagonal matrix (nxm) of ϵ_i current costs of improving the level of education of workers in level i coefficients.

1/ The function a x^2 - bx would provide a more realistic representation of actual variation of investment costs.

Control Theory Models

Kendrick proposes a control theory model in which the initial conditions represent the number of students at various levels in the system, and final conditions represent the targets or the number completing each level in the system in some future year. Controls could be used to determine the number admitted to the first level and the proportion graduating from each level and continuing to the next. He develops a performance index to minimize the total cost of operating the system over a period of n years. Limitations of space dictate omission of a full discussion of Kendrick's model, but its main virtue is that the performance index separates costs into a linear and a quadratic portion and thus seems to approximate the reality of educational technology better than the linear models did. Experience with Schiefelbein's quadratic models and Kendrick's proposed use of control theory model indicates that educational costs and input ratios when incorporated into a multiperiod model become multiplicative and hence quadratic in form. The problem of the control model is that though the general structure has been worked out and there have been engineering applications, there has been no experience in computing with this model in econometric planning situations. Nor is it yet clear whether the data are available for inputting to the model, although this later condition holds for any model until it is tried.

This is the present boundary of work with mathematical models at CSED. Work is now going forward with quadratic programming and no decision has been made on exploring the possibility of gaining computation experience with the control theory model.

This concludes the history of work with formal models at CSED. Researchers there are wiser, but not necessarily sadder after several years of work with formal planning models. Most researchers at CSED no longer harbor lively hope that a single model will capture the richness of an education and training system of any complexity. Schiefelbein probably is an exception to this. He still has hope. They are certain that it is worth continuing work in order to develop models of important components of total education system. It is also clear that these sub-system models can be linked in various ways to produce useful results for planning.

Simulation Models

Linear and non-linear optimizing models exact their toll on the dynamism, flexibility, richness and verisimilitude that they permit in the planning situation. In planning it is better to get families of possible alternatives, rather than a single spurious optimum. If optimization entails assuming away contact with reality or requires aggregation to a level of meaningless crudity then the mathematical programming model has failed of its purpose. No matter how large and how complex and how disaggregated a programming model, its results are always built in from the outset and sensitivity analysis never permits one to identify and characterize the basic components of the system or to test main effects and interactions among them. Simulation and analogue models help avoid some of the rigidity of the optimizing models, but they come no closer to probing the underlying structure of an education and training system than any other conventional analysis method.

Zymelman (1965) advocates the use of simulation models to supplement formal optimizing techniques. His models have a flexibility and simplicity and the output device provides results rapidly and graphically. In fact, the effect of variation of policy on the system can be shown instantaneously with the introduction of changes in conventional paramenters such as student/teacher ratio, system flow rates...Zymelman writes his model in a set of simple differential equations:

Zymelman's Model

$dE/dt = qE$ (1)

$dS_i/dt = (r_i - d_i - g_i) S_i + g_{i-1} S_{i-1}$[1] (2)

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[1] For grade 1 $g_{i-1} S_{i-1} = E$

$S_t = \sum_{i=1}^{6} S_{it}$ (3)

$dT_s/dt = m\,T_s$ (4)

$dT/dt = T_s - a\,T$ (5)

$\sigma_t = S_t/T_t$ (6)

where:

E = entrants to the elementary school system

q = rate of growth of the number of entrants

S_i= number of students in grade i

r_i= rate of repeaters of grade i

d_i= rate of drop outs of grade i

g_i= rate of graduates in grade i

S = Total number of students in the system

T_s= Number of teachers graduating from teachers training institutions that enter the teaching profession

m = Rate of growth of the number of graduates from teacher institutions

T = Number of teachers available to teach in the elementary school system

a = Rate of attrition of available teachers

σ = Student teacher ratio

t = time subscript

Zymelman can compute the values of parameters and initial conditions of the system and input the information to an analogue computer using ratios of volts. The output can be expressed on an oscilloscope with time along the horizontal scale and the values shown in volts on the vertical. If in the system, the student/teacher ratio, an important indicator of the quality of education, becomes unrealistically high, other policy modifications must be introduced into the system.

First Zymelman modifies equation (4) to accelerate the production of teachers with an appropriate lag of three years.

$$dT_s/dt = (m + p_{it})\, T_s$$

where p_{it} is an accelerator based on the tolerable limits of pupil/teacher ratios.

Again, if the resulted student/teacher ratio still does not come down sufficiently and then it must be combined with a second policy, e.g., restriction of entrants to the system.

The point of the exercise is that Zymelman has a highly flexible and adaptable model for testing the results of various policy alternatives. There is instant feedback from the output device. Obviously, there is a limit on the number of variables that can be observed at one time, but many of the main elements of an educational system can be probed in this fashion. The limitations of the model are apparent. Education is still being depicted in highly conventional and stylized terms. The student/teacher ratio may be a meaningless statistic in education. Depending on other conditions (instructional devices, physical arrangements, student ability and maturity levels) the ratio might vary so widely as to be useless as an indicator of anything significant in education. Yet such models must use the ratio as though it had free standing meaning.

The Limitations of All Models

The history of developments at CSED suggests that no model, optimizing, simulating or otherwise, will generate the necessary information which the planner must have to make forecasts and plans for the future. This critical information can only be provided by analysis of political, economic, social and educational phenomena in the world. The analysis, if adequately performed, will reveal the basic dimensions or components of the problem, relevant and observable indicators of the characteristics of these components and relationships among them. This characterization of the components and relationships for present and past status can be used as a basis for estimating possible future status for planning. Only when this basic information is in hand can one have recourse to any model for planning. Even then the model may be useful, neutral or positively harmful. In general, a planner does more harm than good only when he has recourse to a model before performing the necessary analysis and obtaining the necessary information. This is especially true when the model is so complex that it distracts producer and consumer from the task of providing the necessary informational base for planning.

Descriptive Statistics

Planners and researchers will argue that the experience of concocting the model and working with it indicates the data which will be necessary to put in. In this view, the model is a fillip to securing the necessary informational base, rather than the information being a necessary basis for devising the model. If this argument holds in educational planning, then model building should have suggested new kinds of data and statistics which were not used or sought before. This has not been the experience at CSED and it does not seem to be so elsewhere. Model builders work with the same statistics, indices and coefficients that were used by educational planners and administrators who formerly worked with a scratch pad and a sharp pencil. These old standards are enrollments, promotion, retardation and drop-out rates, pupil/teacher ratios, pupil/space ratios, per pupil expenditures, for regular enrollment, average daily attendance or per graduate costs, and depreciation rates for capital expenditure and investment items. All of these are conventional measures and expressions that were used and useful long before the advent of optimizing and simulation models.

At CSED, and probably elsewhere, there has been little ingenuity in devising new constructs and new descriptive statistics for educational planning. Economists use the same old terms that educational administrators have long used. As yet, economists have not brought to the field the same gift for invention and creative heuristic that statisticians and psychologists brought to educational measurement statistics. There seem to be no equivalents to "standard scores," "percentile norms," "reliability" and other useful statistical terms devised to express concepts in educational measurement. No matter how sophisticated the model the planner uses the same old ratios, indices and coefficients. The planner may embed the descriptive statistics in new arrays, and describe them more effectively in matrix notation and operate on them with new rules, but the expressions around which the models are built are the same old, conventional ones. Even the operations performed do not show the utility or ingenuity that is revealed, for example, in the development of varimax or biquartimin criteria in factor analysis. The history of efforts in model building at CSED show no imaginative work on the creation of new statistics to fit the demands of new models. It is unlikely that things are different elsewhere.

The lack of adequate descriptive and analytical statistical constructs and terms is one problem for planners. Getting an adequate data base is another. Without the basic data no model will work.

The Necessary Knowledge for Planning

There are three essential information bases necessary for educational planning. If the planner has good estimates in these three basic areas of information it really matters very little what kind of model he incorporates them into, or how he operates with them. With good estimates in hand, he can plan; without such estimates he can only go through the motions, and as those motions become so elaborated as to be difficult to follow they may even be pernicious.

The three information components can be variously called, but in honor of the economists it seems only fair to use their terminology:

1. The demand or requirements vector
2. The resource vector
3. Input-output relationships or technology-cost coefficients

The Demand Vector

An informed basis for estimating future requirements for educated and trained people is essential for the educational planner.

The planner must have these basic estimates in order to plan the kind, scope and size of education and training programs necessary for the future. In the newer planning models there has been much stress on the so called economic demand for education, i.e., workers for some future year classified according to education-training levels. The education-training levels are derived from the occupational structure of the work force, which is related to the activity sectors of the economy which is related to the total output of the economy. Other demands, political, social and cultural are alluded to in plans but the most explicit analysis is directed to estimation of the economic demand, perhaps on the mistaken notion that the economic demand is the most straightforward estimate to make. It isn't easy, but it is necessary.

However the matter is viewed or approached, the planner needs an estimate of future requirements. No general prescription for estimating these requirements can be offered, and the planning approach will vary according to the aspirations and resources of each country or autonomous educational entity. The country may aim to provide a general or basic education of specified length to all its citizens within a certain age range. The demand vector then is the population in the specified ages projected for the years of the plan. The planner's model is the projection model of the demographic statistician. There have been no recent improvements in the general demographic models which incorporate the components of birth, death and net migration into forecasts. New methods are constantly being devised for analyzing the components and improving estimates of present and likely future value, but most of the ingenuity goes into devising ways to obtain or improve data, or to minimize the problems that come from lack of data. Undergirding the basic model is extrapolation based on rudimentary fits to curve functions. The functions must be kept simple. The more elaborate the curve the more extensive the data required to fit to it. There is research in abundance to be done in demographic statistics, but it is questionable how much the educational planner will or can contribute. He may devise new routines for obtaining or combining data for sub-national projections, but contributions to basic models or methods are unlikely.

Beyond the general education level the planner has the problem of estimating the numbers to enter and leave special education and training programs. The goal of a universal, general education may reflect social, political or cultural demand. Education is provided without respect to its contribution to enhancing productivity or increasing output. When education is sought in order to increase output or enhance productivity it reflects the so called economic demand. The demographic projection furnishes the basis for estimating the numbers available to enter specialized programs of education or training designed to meet the economic demand. If the planner knows how many go in and rates of transition or flow through the system he multiplies to get an estimate of how many will come out. If he knows the number required to come out and the rates of flow, he can estimate the number that must go in. Flow analysis furnishes the rates of passage through the system. Economic, political, cultural and social goals furnish basis for estimating the number required to come out of the system.

The basic model for flow analysis is straightforward. It involves the number which enter and three rates, promotion, retardation and drop-out (death, desertion or disappearance outside the system). The basic model for an educational level with three steps or grades:

$$\begin{bmatrix} r_{1t} & 0 & 0 & 0 \\ p_{1t} & r_{2t} & 0 & 0 \\ 0 & p_{2t} & r_{3t} & 0 \\ d_{1t} & d_{2t} & d_{3t} & 1 \end{bmatrix} \cdot \begin{bmatrix} E_{1t} \\ E_{2t} \\ E_{3t} \\ E_{dt} \end{bmatrix} + \begin{bmatrix} E_{1,\ t+1} \\ E_{2,\ t+1} \\ E_{3,\ t+1} \\ 0 \end{bmatrix} = \begin{bmatrix} E_{1,\ t+1} \\ E_{2,\ t+1} \\ E_{3,\ t+1} \\ E_{d,\ t+1} \end{bmatrix}$$

$$A \quad . \quad X \quad + \quad Y \quad = \quad V$$

Leaving out Y, which can be added in later, if we know A and X we can multiply them to get V. If we know V and A we can solve for X by inverting A.

$$AX = V$$

$$X = A^{-1}V$$

Flow

The models for estimating flow through the system are straightforward and need no comment. The problem is not to improve the model, but rather to improve the estimates of the promotion, retardation and drop-out rates which go into matrix A. The author has discussed the problems of estimating flow coefficients and there is not much to add to previous analysis. All methods are approximations of cohort analysis and all cohort analysis has the difficulty of being a longitudinal study. It is difficult to follow individuals in the cohort over time, and it costs more in time and money than is generally available. The planner usually has time only to make a simple, cross-sectional analysis on a sample of individuals. This can be used to construct the history of the cohort, and thus a cohort analysis can be simulated and rates estimated. When rates from the past are applied to the future, there is the classic problem of using past experience as a guide for the future.

Demand

There are two problems in estimating the final demand V. The first comes from the difficulty of estimating final demand in work force terms, i.e., employment in occupations. The second problem comes in fitting occupational demand to education and training programs. The basic model for estimating work force demand is a simple one.

$B^t = \left[e^t_{ij} \right]$	B is a matrix of employment frequencies classified by occupation and industry in year t.
$A^t = \left[a_{ij} \right]$	A is a matrix of relative frequencies, i.e., the percent or proportion of employment in industry j, occupation i.
$a_{ij} = \dfrac{e_{ij}}{E^t_j}$	The a's are the proportion employed in industry j in the ith occupation

The planner has A matrices for various time periods in the past:

$$\left[a^{1940}_{ij} \right]_{m,n} \quad \left[a^{1950}_{ij} \right]_{m,n} \quad \left[a^{1960}_{ij} \right]_{m,n}$$

He can fit a curve to the a_{ij}'s over the time periods and obtain a matrix in which the elements are a function of time. If U_t is that matrix, then:

$$U_t = \left[f^t_{ij} \right]_{m,n}$$

Instead of basing the analysis on time the planner might also borrow the a_{ij}'s from another country or a group of them. However he does it, the basis is weak.

If the planner has total employment in all industries known for some time period t, then he can form a nx1 vector: $V^t = E_j^t$ The m occupational employment levels at t can be denoted by a mx1 column vector.

$$W^t = R_i^t$$

$$W^t = U_t \cdot V^t$$

Expanded

$$R_1 = f_{11} E_1^t + f_{12} E_2^t + \dots f_{1n} E_n^t$$

$$R_2 = f_{21} E_1^t + f_{22} E_2^t + \dots + f_{2n} E_n^t$$

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$$R_m = f_{m1} E_1^t + \dots\dots\dots\dots\dots f_{mn} E_n^t$$

V^t is the total employment and U_t distributes it among occupations. The basis for U_t has been described as weak. The basis for V^t is equally weak. It is generally based on a projected ratio $E_j^t = \frac{\text{Output industry j}}{\text{Output per head}}$. The problem of improving both V^t and U_t estimates is more appropriately the task of the manpower economist than of the planner, but after extensive experience with planning models and manpower analysis one comes to doubt if improvement will ever be possible along conventional routes. Even if the methods of estimating work force requirements were much improved, there would still be the second main problem of matching education and occupation.

An entirely different approach to the problem seems to be required if planning on this basis is to be reliable enough to be worth using. A vast amount of research is necessary, but the steps for the necessary research can be sketched out:

1. The job performances of members of the various occupations are observed and characterized.
2. The performance characteristics are subjected to a principal components analysis to yield major factors.
3. Groups are formed by a hierarchical grouping on factor scores.
4. These groups are examined to see what characteristics describe the members' performance and what kinds of education and training relate to this performance. This permits the researcher to write explicit rules for membership in the occupation-education groups.
5. A discriminant analysis is run to test the extent to which the groups separate from each other.
6. Grouping is validated by assigning individuals to groups on a probabilistic basis by factor scores; the predicted

membership is compared to actual to test the accuracy and precision of the classification procedure. This procedure goes on until groups are optimally structured.

7. Successive discriminant analyses are run and individuals are assigned in order to test overlapping and misclassification.
8. All relevant and major occupations can be sorted into these major groups. When work force needs are projected in terms of these groups the projection will automatically yield education-training needs. This advantage will not come without cost, however.

The world of work is divided up into occupation-education groups. Since the groups will be much larger and more general than the present detailed occupational categories there will be a loss of precision. It should be compensated by a gain in accuracy, however, as the present categories have many distinctions that have no relevance as far as education and training go. Estimates will always have weaknesses. Uncertainty must always characterize any attempt to estimate the future. There will always be changes in technology which will bring changes in work force requirements and education. Large numbers of individuals will change jobs and skills during their work life. Any method or model must strive for as much detail as possible without locking the planner into spurious precision.

The point here is to avoid spurious precision in the demand vector, but not to ignore it completely. The models developed at CSED ignored the demand vector. As comprehensive and formidable as the multiperiod linear programming model appeared to be, it ignored the problem of the demand vector almost completely. Education and training requirements defined in work force terms were derived exogenously, and the planner assumed that there was no substitution between education and skill classes. Demand was varied parametrically in the models and the effect on other values and parameters studied, but there was no basis for the estimation of demand in the first place.

The Resource Vector

The allocation models developed at CSED were totally inadequate in providing a basis for estimation of future resources. The total of resources available for education was assumed or crudely estimated from previous allocations. The categories of available resources and the amount available in each category had no basis in systematic estimate. Resource estimates can be discussed under two headings, human and fiscal.

The estimation of human resources has previously been discussed. The number of trained people to man the education and training system are estimated as part of the general demand. Demographic projections provide the estimates of people to enter the educational system. These people are then sent through the system in flow models and the simulated output is compared with the demand vector. If the simulated output and the demand do not match, then the targets of the plan must be scaled down, or the output of the system must be increased by taking in greater numbers or by pushing greater numbers through the system. These adjustments will cause further adjustments throughout the model and the plan. Programming models have their major advantage in precisely this aspect of iterated estimate, test, adjustment, estimate. The model will guarantee that the estimates and re-estimates remain consistent within the limits imposed by the planner at the outset. Only a comprehensive model can cope with the problem when very large numbers of values are being changed simultaneously.

The estimate of fiscal resources available is clearly the economist's task. The routines used in most plans are crude in the extreme. An estimate of gross national product is first made and the planner then estimates that education will receive some proportion of this product in future years. Sometimes future national budgets are estimated and a certain portion of the budget is estimated as likely to be provided for education. Other models estimate product in the economy, derive income and then estimate revenue from income on the basis of tax and public revenue policy. This exercise yields an estimate of the amount available for public expenditure, and education will command some portion of it. The demand for private education can be based on estimates of movement in personal income and possible future patterns of consumer preference, but the estimate gets shakier. Again there is nothing complex about the models. The challenge lies in choosing indicators to reflect how educational revenues will move and making estimates of how these indicators will move. No model helps to select the relevant indicators or to minimize the uncertainty and error in estimating them in the future.

Technology, Cost and Output

Lastly the planner must have accurate and precise information on the present performance of the educational and training system. He must know what goes in, what this input costs and what it produces. He must know the present input-output status and more importantly have some basis for estimating the future performance of the system. In reality it is not easy to determine inputs to a large education and training system. It is even more difficult to determine the cost of what goes in. To date, it has been almost impossible to determine what comes out and it has been absolutely impossible to relate what goes in to what comes out.

No model can spare the planner the necessity of knowing something about the technology of education. The planner must deduce from program type and level of activity (shown in the demand vector) the kind of technology required. The choice of technology will govern the inputs and these in turn determine the costs. On the input side then the planner must have schemes for relating technology to input schedules. This is the heart of administrative and fiscal planning in education. The planner must have accounting routines for determining the costs from analysis of inputs and costs. This sounds easier than it is in practice. In actuality the school is open and running and only searching diagnosis and detailed inventory will reveal what has gone into the system. These inputs, already employed, must be costed. Ingenious accounting techniques are sometimes required. How does the planner value unused taxable property bought as a hedge against future land scarcity? How does one account the input of volunteer helpers? What are different professional degrees worth? Every input must be costed if the planner is to know how to plan provision for the future. On the basis of present inputs and costs, estimates for future inputs and costs can be made.

None of the input and cost analysis is easy to do, but when compared with the difficulty of estimation on the output side everything else seems simple. All models devised to date, at CSED and elsewhere, have ignored the problem of educational output, or else, have handled it in such a simple way as to make it meaningless. At base lie some very severe problems of devising measurement criteria as the following sketchy presentation will attempt to demonstrate.

Criteria Problem in Sketch

Objectives

Indicators	Characterization	
1. Observable	Present	Absent
2. Relevant		
3. Representative	Degree	
	(Scale)	
	Absolute	Normative

Relation to Input

At this point only the lineaments of the problem can be sketched. There is first the difficulty that most education and training has multiple objectives and there must be a determination and selection before evaluation can begin. There may be cultural, political, social or economic objectives and the Indicators chosen for observation will differ according to the objective chosen for evaluation. Objectives may even conflict or contradict each other. Once objectives are determined indicators must be sought. The indicators must be observable or no characterization or evaluation is possible. The indicators must be relevant to the objectives, and enough of them must be chosen to represent the objective. The indicator may be observed and characterized merely as present or absent. If present there must be an appropriate scale (nominal, ordinal, ratio) for expressing the degree to which it is present. Characterization along the scale can then be expressed absolutely or normatively i.e., with respect to other characterizations. After all this is done, characterization must then be related back to the education or training situation so that the input-output relations can be determined. This is obviously a crude and incomplete treatment of a subject that requires a volume to itself. Even so, this much can be said. Until there is far more evidence collected, on the problem of criteria in education and until observation of the criteria yield measurements of attainment that can be related to input and cost measures the best planning models will be ignoring the fundamental problems of education and training.

Part Two

Strategies of Human Resource Development

A Systems Approach to Educational Organization [1]

Roy W. Jastram

I shall define a systems approach to organization as one which explicitly establishes a structure which allows for, and facilitates, integration of sub-systems drawn from various functional areas toward the achievement of goals for the organization as a whole.

The State-level system of educational administration must be organized so as to insure that the following major functions are effectively carried out:

1. Sensing emerging needs for educational development in the State and for related changes in the State's educational system.
2. Assigning priorities and allocating resources among

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[1] An organizational study of the California State Department of Education has recently been completed by Arthur D. Little, Inc., the Cambridge-based research and consulting firm. I was a member of the study team; and the present paper follows closely portions of the resulting report. For the full report see A New Organizational System for State-Level Educational Administration, California State Department of Education, 1967, pp. 242.

areas of discovered need in the context of comprehensive and integrated State plans for education.

3. Providing for the design of new instructional programs and services, and the stimulation and support of new educational developments to meet discovered needs.
4. Evaluating both new and established educational programs and services, the ways in which such programs and services are planned and administered, and requirements for redirecting allocations of human and material resources.
5. Facilitating the dissemination of information regarding new instructional programs and services and their effects.
6. Encouraging and supporting the adoption of new educational developments and improved instructional programs and services.
7. Assuring the quality of educational offerings in accordance with legislative mandates and as required by regulations of the State Board.

A common factor in all seven major functions of the State-level system of administration is the critical need for "information processing" capabilities, very broadly defined, of a high order. It is helpful to conceive of the Department as a switching center in a giant, complex information network, much of which it must design and manage. It must be responsive to requests for information and information services from a tremendous number of clients representing different interests and manifesting different concerns, i.e., it must function as a comprehensive and efficient inquiry system. Not only must the Department collect and disseminate basic data and trends regarding social conditions and values, manpower requirements, the learning process, teacher needs and teacher conditions, population changes, facility requirements, educational economics and finance, educational offerings, and characteristics of the products of schools, but it must also digest and translate such information into reports present and future needs. These reports must be distributed to appropriate potential users, including intermediate units and local districts, and assistance must be provided, as necessary, in interpreting the significance of such information in the light of interests and needs of the users.

This information system is concerned with data from a variety of sources which is collected in a number of ways including, among others, regular reports from various elements in the education system regarding routine monitoring of programs and adherence to minimum standards, through meetings and conferences, from reports of workshops and seminars, from Departmental evaluation studies, and significantly from published literature on new trends, developments, and research results. Some of the most creative and potentially important information sensing is done by people in local districts, intermediate units, and the Department, in various combinations and interactions, who synthesize their observations and share them with others. Contacts and linkages with universities, educational research and development centers, regional educational laboratories, educational research information centers, and "lighthouse" schools both in and outside the State provide means of obtaining information regarding educational developments and their effects. The Department sponsors, sometimes conducts or participates in, and publishes results of special studies. It helps put people with questions and people with expertise in contact with each other and catalyzes the interaction. The Department should not be viewed or represented as the primary originator of new knowledge, but instead should be regarded as a collector, compiler, synthesizer, interpreter, disseminator, stimulator, and facilitator of the use of new knowledge. (Some significant exceptions to this general statement are recognized, e.g., evaluation studies conducted by Departmental personnel, and major programs to develop new preschool or adult education offerings and services.)

Our proposed new organizational system responds to this critical functional requirement by placing new emphasis upon the skills, manpower, responsibility and commitment, and the organizational structures and linkages required for the sensing, collating, evaluating, storing, retrieving, disseminating, and interpreting of information for use by those interested in and responsible for public education in California.

A second important and pervasive factor in the functional requirements of the State-level administrative system is the need for increased capacity to respond quickly to identified problems and opportunities, and to mobilize effectively the resources most relevant to understanding and solving the problems and exploiting the opportunities. This requires organizational flexibility much greater than that afforded by traditional organization styles and structures in state departments or education, particularly, if the spectrum (mix and level) of skills required to deal effectively with a complex problem is to be applied in the amounts and at the times appropriate. The proposed organization structure affords opportunity for greater flexibility in the selective use and development of professional skills within various elements of the Department and in the identification, mobilization, and use of specialized skills from many other sources.

A NEW ORGANIC ORGANIZATIONAL SYSTEM FOR STATE-LEVEL ADMINISTRATION

An "organic" system is one in which the operational or functional characteristics and the structural configurations of an organization system are both (a) highly interdependent, and (b) related specifically, i.e., "custom designed," to the essential functions and tasks which must be performed in carrying out the mission(s) of the organization system. In general, state departments of education are composed of organizational units which individually are oriented toward carrying out specialized functions, but interdependence among such units is typically lacking.

The previous enumeration of the major functional requirements of the State-level administrative system for public education indicates the need for considerably more interdependence in comprehensive planning, in the utilization of a broader spectrum of talent in dealing with important issues, and in more effective management of complex programs and projects, particularly those involving personnel drawn from two or more divisions and from outside the State Department. Organizations significantly concerned with large, unique, and complex projects or programs require a style of management and a set of management processes and capabilities different from those which are organized along traditional lines of functional specialization.

In industry, the traditional form of a functionally specialized organization is based on the expectation of a continuous flow of basically similar products and services. Different functional areas (e.g., engineering, marketing, production, and procurement) of a company are frequently able to achieve high degrees of efficiency due to the learning opportunities afforded by repetition of similar processes and increased familiarity with the same or similar materials, information, problems, products, and people. Members of the organization are reinforced in their learning of specific behavior patterns and they become accustomed to the various routines of the organizational system. As a rule, as such learning takes place, functional specialization increases, the division of labor among and within functional areas becomes more refined, and work patterns and operational systems become institutionalized. In the absence of significant internal or external pressures for change, the organization "jells" and achieves a rather stable equilibrium.

In the last few years a number of companies have found it advantageous to depart from the traditional functional form of organization and set up what are typically called "project organizations" to handle special assignments such as investigating the feasibility of establishing a new business, developing a new product line, or servicing the unique requirements of new customers.

Ordinarily, a project organization in industry is responsible for completing an assigned complex task on schedule, within certain cost and profit specifications, and to established standards. Because the task is both complex and usually new to the company's experience, it requires special management emphasis.

The life span of a project may be as short as a few weeks or it may extend for a number of years. Short-lived projects may be staffed simply by borrowing personnel from various functional areas to serve on an ad hoc task force on either a full-time or a part-time basis. In such cases the borrowed personnel may never be formally transferred to the project organization. However, for long term projects the borrowed personnel are usually transferred to the project organization.

The project organization approach in industry is usually most applicable to important one-time undertakings which are: (a) unique or unfamiliar to the organization, (b) complex in terms of the interdependence requirements among representatives of various disciplines of functional departments, and (c) definable in terms of specific goals and objectives. Frequently, project organizations are mobilized to conceptualize and produce a new product, in which case the emphasis is phased sequentially on research, development, evaluation and testing, and production.

In a recent article[2] C. J. Middleton discusses the process of setting up a project organization in industry. After surveying the uses and results of both traditional functional organizations and project organizations in a number of aerospace companies, he concludes that, "Functional organizations often cannot accomplish unusually complex or markedly different projects because of these conditions:

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[2] "How to Set Up a Project Organization," C. J. Middleton, Harvard Business Review, March-April, 1967, p. 73.

* No one in a functional organization besides the company or division manager is entirely responsible for project costs and profits. Functional department executives are concerned only with doing specialized work within budget.
* Functional departments often are jealous of their prerogatives, and fight to promote and preserve their specialties rather than work toward a unified project objective.
* The total perspective of a project is lost among functional departments. They can be guilty of 'tunnel vision' - that is, a concern for only their own portions of the task without regard for the impact of their actions on the company and on the project.
* More and faster decision making is required on a new project, and it is slowed by passing interdepartmental problems to the top through all levels of functional departments. This process often delays important project decisions or prevents them from being made.

- * Functional departments performing repetitive tasks often lack the flexibility and responsiveness necessary to cope with new and rapidly changing project requirements."

In establishing a project organization, its size, structure, and the management and functional elements necessary for project control are governed by the desires of top management and by company and project circumstances. A project which is drastically different from the normal business of a company generally will require a more self-sufficient project team than projects familiar to the functional departments. Companies which are rigidly organized along functional lines and which have difficulty in obtaining effective joint collaboration across departmental boundaries or among specialized functions ordinarily will establish more complete project organizations under the direct supervision of the project manager than those companies which are accustomed to multidepartmental efforts.

In order for project organizations to be successful: (a) the project manager must possess superior leadership ability and managerial skill, (b) he must have achieved a high position of responsibility, (c) the position of project manager must be one of high status, i.e., his salary, benefits, title, and influence must be commensurate with those of managers of functional departments, (d) he must report to a manager who is on the same level as the manager to whom functional managers report, (e) the extent of his authority over the project and his role in working with and through functional managers must be defined, and (f) he must be supported by top management in his dealings with functional managers.

We have found that the increased management attention resulting from effective and extensive use of project organizations has a number of effects which we believe are vitally important to a State Department of Education:

1. Careful and comprehensive planning is emphasized and the rapid and efficient mobilization of necessary resources is facilitated.

In order to survive in a rapidly changing industry, a company must be able to move fast in capitalizing on what may be transient opportunities. A project manager and his planning staff usually can select and assemble critical information, talent, financing, materials, and equipment more effectively than can be done by the dispersed functional department managers whose orientations may be different and whose time and attention may be otherwise engaged.

2. Budgeting and cost control is usually more effective.

Improved program budgeting and accounting techniques are usually developed and applied to project management. Coordinated and systematic follow-up assures effective use of available resources.

3. Tasks are better defined and performance is more closely

monitored.

Because of the critical importance of the performance of people, personnel administration and management development systems must operate most effectively. In those industries affected by knowledge explosions, by significant changes in the state of the art, and by consequent rapid technical and professional obsolescence, provision must be made either for personnel development and renewal or for significant turnover.

4. Action is typically initiated sooner to prevent or correct problems.

Special management information systems are frequently utilized to detect changes in the market or in the competitive environment, to provide feedback information regarding progress to performance budgets, and to evaluate the quality and acceptance of output.

5. Project organizations usually can evolve and change more readily than functional organizations in response to changing conditions.

The flexibility inherent in a project organization facilitates its transformation to a full-fledged division or the transfer of standardized and repetitive processes back to functional departments if it is successful. On the other hand, if its purpose is fulfilled, if the project is unsuccessful, or if its usefulness declines or ends, it can be phased out or terminated with minimum trauma to the parent organization.

It is obvious that these attributes and effects are important to State-level educational administration, particularly in the light of our earlier discussion of the major functional requirements of the State-level administrative system. It should be noted, however, that the use of the project organization approach is not feasible for all organizations. It certainly is not a panacea for managerial deficiencies. It requires a high order of management skill, the use of advanced management techniques, a high degree of cooperation, and willingness to change traditional styles of work and management on the part of project team members, project managers, and managers of functional departments.

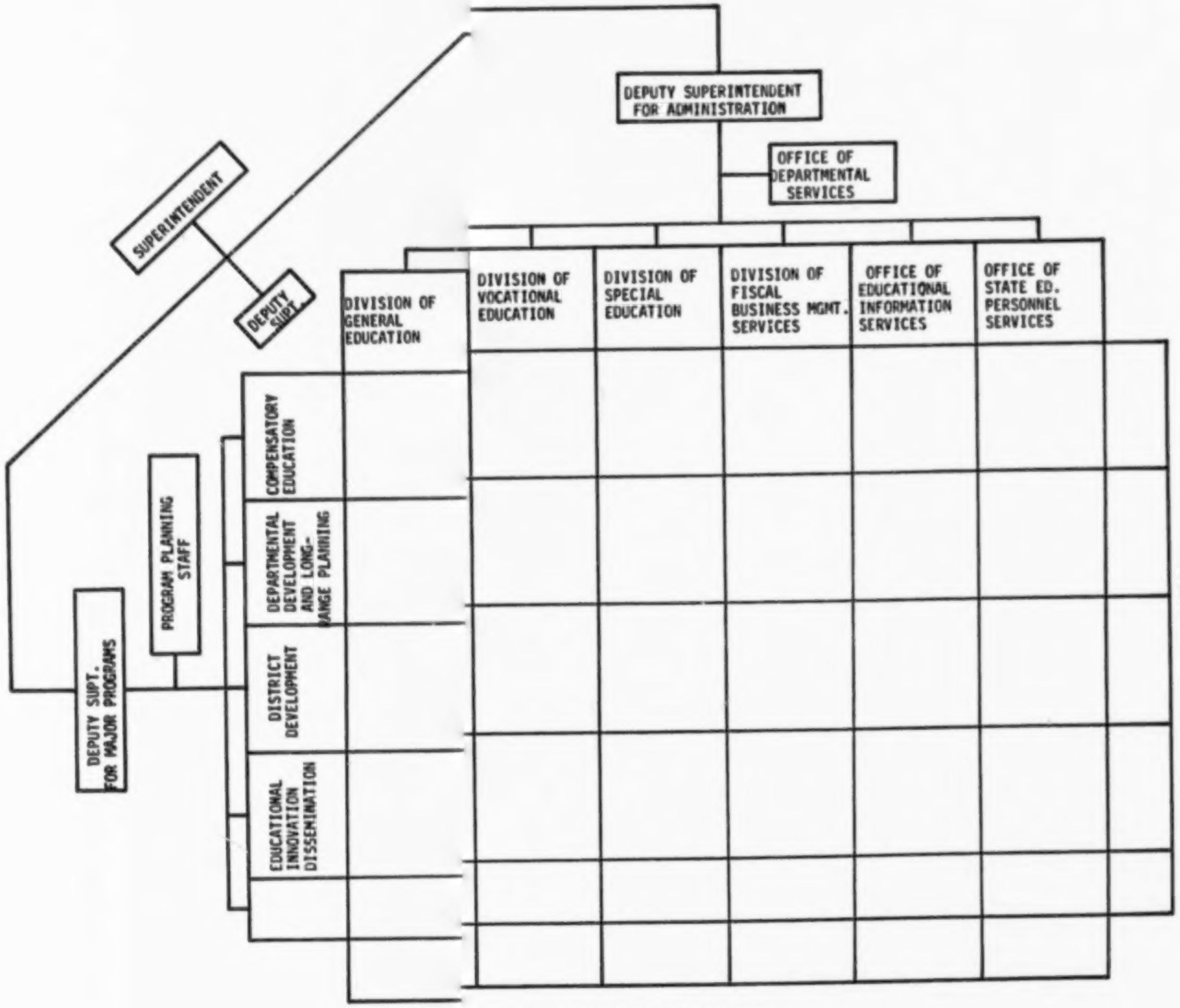
It is often necessary to guard against overemphasis of the project organization approach and overenthusiasm for it, particularly on the part of customers and clients. Large numbers of project organizations in a company produce confusion and compound management problems. Personnel shifted frequently and continually from project to project are not able to make effective contributions and eventually become discouraged and disenchanted with the concept. Overattention to projects and the consequent requirement for immediate and short-term planning detracts from the attention which should be applied to long-range planning.

We are recommending an organic organizational system for State-level educational administration in California which is based, in part, on tested applications of the project organization concept in (a) rapid technological change, (b) a very high proportion of professional personnel, (c) varied programs and product lines requiring large investments in development and evaluation, and (d) the use of multidisciplinary teams for indeterminate periods of time where teams are composed of professional personnel who are obtained from a variety of functionally specialized units in the company and where personnel may participate (on a part-time basis) in two or more concurrent projects.

Recommendations for a New System of Organization within the Organic Structure of the Department

As indicated earlier, we strongly believe that a new, more interdependent and flexible organization system is needed if the State Department is to manifest significantly improved functional capacities in meeting emerging requirements for State-level leadership in educational administration. The system we propose is "organic" in the sense that organizational elements and processes are highly interdependent and are designed specifically to fulfill the major functional requirements involved in carrying out the missions of the Department.

The recommended organizational system (shown in the Figure) relates to precollege (K-12) education and has two dimensions or axes. The right-hand axis consists of [illegible] familiar organizational units known as divisions and offices. We call this the "administrative" axis. The left-hand axis is comprised of organizational units particularly concerned with broad educational issues or sets of complex problems which require unique and very considerable multidisciplinary attention in their treatment. We call this the "major program" axis.


SUPERINTENDENT
DEPUTY SUPT.
DEPUTY SUPERINTENDENT FOR ADMINISTRATION
OFFICE OF DEPARTMENTAL SERVICES
DIVISION OF GENERAL EDUCATION
DIVISION OF VOCATIONAL EDUCATION
DIVISION OF SPECIAL EDUCATION
DIVISION OF FISCAL BUSINESS MGMT. SERVICES
OFFICE OF EDUCATIONAL INFORMATION SERVICES
OFFICE OF STATE ED. PERSONNEL SERVICES
DEPUTY SUPT. FOR MAJOR PROGRAMS
PROGRAM PLANNING STAFF
COMPENSATORY EDUCATION
DEPARTMENTAL DEVELOPMENT AND LONG-RANGE PLANNING
DISTRICT DEVELOPMENT
EDUCATIONAL INNOVATION DISSEMINATION

RECOMMENDED ORGANIC ORGANIZATIONAL STRUCTURE
FOR THE STATE DEPARTMENT OF EDUCATION

The State-level administrative agency for community college education is envisioned as operating separately from the Departmental organization.

The divisions and offices on the right-hand axis represent the administrative "homes" for practically all professional personnel in the Department. As the Department defines the need for plans and develops, and staffs major programs which qualify for "program axis" management, professional personnel from the divisions (supplemented as needed by outside temporary or "instant" staff) will be assigned to work on such programs for such portions of their time as is appropriate to the defined needs of the major program and to the competing, ongoing needs of the services and functions performed in the divisions.

Major programs will be managed by program managers released from the divisions or obtained from outside the Department. They will be expected to work full-time in program management for the duration of the program, or until rotated or replaced. When program assignments are complete, the program manager and program personnel return to their own division for reassignment or, in the case of term appointments of "outside staff," they are released. Program managers must be carefully selected to represent an unusually high order of professional qualification and managerial competence (particularly in managing a group of people representing diverse backgrounds and disciplines). Program managers are most likely to be chosen from the management levels of division chief through bureau chief. Salary administration, personnel development, and "functional" supervision of program personnel "borrowed" from the divisions continue to be the responsibility of division management, utilizing assistance and feedback information regarding staff performance from the program managers.

On the right-hand axis, the four division chiefs and the two directors plus the Director of the Office of Departmental Supporting Services report to the Deputy Superintendent for Administration who in turn reports to the Superintendent. On the left-hand axis, the Deputy Superintendent for Major Programs reports to the Superintendent and is responsible for the planning and management of all programs which qualify for the "major program axis."

The deputy for Major Programs has a small permanent planning staff, possibly three or four Major Program Planning Coordinator

These Coordinators should be broadly experienced and highly skilled program planners and developers. They will assist the Deputy for Major Programs and others in synthesizing information suggesting the need for special programs, in drawing up proposals to evaluate the need for major programs, and in planning the studies or major programs that appear to be required.

It is evident that the definition of a "Major Program" is critically important to this recommended new organizational configuration. We have developed several suggested criteria and offer them below. It would be unwise - as well as virtually impossible - for us to define neatly and precisely what should and should not qualify as major programs. Definitions and criteria should be modified and refined through actual experience and in response to changing needs. The inherent flexibility of the system permits the tryout of different criteria and various kinds of major programs.

In our estimation, the primary identifying characteristics of a major program, in approximate order of importance are as follows:

CHARACTERISTIC	IT APPLIES
1. The program addresses an identified major issue or problem in education or a related set of problems.	Always
2. Skills required for program staffing are multidisciplinary and are drawn significantly from more than one division and/or from outside the Department.	Always
3. Program objectives and professional skill requirements are carefully defined and specified in a program plan.	Always
4. Evaluation of the degree to which objectives	Always

are achieved is part of the program, and program planning provides for such evaluation.	
5. Budget is allocated to the program, there is a budget limit, and budget applications within the program are carefully planned.	Always
6. The program requires full-time management.	Always
7. The program schedule is time-limited, such as ten months, two years, or thirty months.	Frequently
8. The program is funded from multiple sources and/or is carried out under multiple authorization.	Sometimes

Other general characteristics of major programs are that: the need for treatment of a problem area is critical; the need for action is immediate; effective mobilization and utilization of appropriate resources is required; and the problem is so unique or complex that the resources of any one existing division are not fully appropriate to the requirements. Frequently, major programs will be somewhat interrelated or at least involve complementary tasks or functions. This is a further reason for being grouped under the management and supervision of a single deputy superintendent.

In some instances, major programs will be designed to produce a change in educational practice and the product of the major program is to be used by the staff of intermediate units and local school districts. Products produced by such major programs may be utilized or disseminated by other major programs on the left-hand axis, or by divisions or units of divisions on the administrative axis.

Some major programs will be designed to produce information or plans useful in developing or changing educational policy. Such programs may need to be followed by additional major programs which explore the methods by which policy changes can best be implemented and the results of implementation evaluated.

Major programs might be set up to develop services or systems to be operated by a division or office. Other programs could disclose that functions or services offered by the Department should be modified or discontinued.

There may be from four to ten major programs in progress in the Department at one time. Others may be in the planning or developmental stage. Some people have argued that all Departmental activities should be conceived of and operated as programs. We believe that the style of "program management" is appropriate for many activities carried on within divisions, but many of the time indefinite activities of divisions (such as processing applications for teacher certification and operating the information system which results in the apportionment of state monies) do not meet the criteria or fit the suggested definitions of major programs as described above.

The new flexibility afforded by the "organic diamond" organizational system permits major program managers to "fine tune" the mix of professional skills applied to their programs by arranging agreements with division and bureau chiefs to use selected personnel on a part-time basis (perhaps three days a week for a period of four months). This should be a vast improvement over the traditional mode of employment: Either you transfer permanently to a given unit on a full-time basis, or you don't work for the unit or on its project. Professional staff hired on a temporary or term basis by divisions or bureaus can be used to "fill in" for the staff time employed on major programs.

The concept of the organic diamond with the program axis cutting across traditional organization boundaries to form multidisciplinary task-oriented teams encourages and even forces a broader Departmental view of educational issues and problems as opposed to a divisional, bureau, or particularistic view. It discourages the tendency to take a narrow or parochial view of the Department's role, it stresses the need for improved interdivisional communication and planning, and it requires the application of modern management methods and techniques.

The organizational concepts and processes we propose require and even force more effective management of time, budgets, and human resources. Our scheme fits well with and will expedite the required change to program planning and budgeting. It places new demands upon the budgeting process and especially upon the planning process which precedes budgeting; e.g., defining program objectives; translating program objectives into skill requirements in terms of degree, kind and duration; and converting professional staff time into program costs. The new style of organization, with several individuals assigned to one or more programs for limited times, requires improved technology for time-accounting and for cost allocation. Since programs should be oriented toward educational problems or issues rather than toward the source of funding, the potential for funding from multiple sources is greater and therefore the demands upon cost accounting and report preparation will be more complex. It is obvious that an improved management information system is necessary.

The proposed organic structure provides increased opportunities for much needed professional personnel development. It is possible to allocate only a portion of a person's available time to a single task, thereby allowing him to work on several concurrent tasks. By proper planning, an individual can shift from one type of assignment to another of quite different demands so that his job experience is broadened and varied. Training experiences specifically appropriate to the needs of individual professionals should be identified and provided. By working on several programs or projects, the individual is able to work for several supervisors and with team members possessing different skills. He can learn from their varied capabilities, thereby adding to his own versatility.

The competition among major program managers and division chiefs for the best staff will cause those persons who perform successfully to be in much demand, and those who perform poorly to be unsought. This provides important information for use in salary administration, in assigning tasks, and in planning developmental experiences for individual staff. In addition, the internal competition for staff with recognized capabilities will require division and bureau chiefs to justify their reluctance to release key staff to important programs by [illegible] such staff are critical to the achievement of specific objectives related to an established hierarchy of priorities. This is another demonstration of the value of good program planning.

Inherent in our recommended organizational scheme is considerable potential for more flexible and varied use of professional staff. Effective exploitation of this potential will require a style of leadership and followership new to the Department. A professional may work for two or three managers on different programs going on at the same time. Organizational myths notwithstanding, it is quite possible. Scientists, researchers, consultants, and engineers, who work on various development teams or task forces have demonstrated that it can work, and to the organizational health and benefit of the enterprise.

A bureau chief "on loan" for three months still will be required to meet some performance standards placed upon him by his division chief. The budget analyst assisting a program manager in budget planning and budget control will need to satisfy standards of accounting and financial practice imposed upon him by his divisional leadership. The system analyst helping a program manager prepare data for computer processing will need to use standards of systems documentation imposed upon him by his divisional management. This multiboss society will require new kinds of communication and coordination among those in leadership roles, and new senses of individual responsibility and initiative when one's role is -- for the moment -- to follow. Teamwork and the coordination of work with one's peers will get new emphasis.

Planning will require new and increased attention. When programs are time limited, they come to an end. Management will be required to sense what new work is most important. This will require long- and short-range planning and priority setting. The constant flow of information about program budgets and the allocation of individuals' time to these programs and projects will help management "attend to what it is getting for its money" with an urgency not experienced prior to program management. Objectives setting, evaluation of achievement, limited budgets, and a limited reservoir of human resources impose the discipline of priority setting upon the planning process, and may encourage cost/benefit estimates to guide priority setting. Accounting for time expenditures of professional personnel will facilitate value or benefit comparisons between applications of time to programs or projects versus applications to meetings with professional associations. Such comparisons may result in new approaches to professional development and in new efforts and improved results in the management of human resources.

This paper, and the work from which it derives, pertains to educational organization at the State level. I do think, however, that it may be suggestive for organizational forms for intermediate units within the State and for large local districts.

Inter-Firm Correlations: The Contribution of Educationally-Heavy Inputs to Increasing Profitability

Richard H. P. Kraft

This paper is addressed to one form of manpower forecasting -- inter-firm correlations. The underlying premise of this approach is that firms and industries differ in their relative emphasis placed on schooling just as much as countries do. But as with the international comparisons, there are many variables which make it extremely difficult to draw general conclusions from comparisons of firms or industries. Perhaps there is no entirely satisfactory way of measuring a firm's emphasis on "training," or on "education," and oftentimes the empirical difficulties of this approach are immense. Once these difficulties have been overcome, however, correlations can be made between the indices of "education received" and the indices of profitability of the firms involved.

International, inter-temporal, as well as inter-industry and inter-firm comparisons of GNP and educational expenditures by themselves are not new. Such comparisons have been made on cross-sectional bases with individual countries and between countries.[1]

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[1] See Nicholas DeWitt, Education and Professional Employment in the U.S.S.R. (Washington: NSF, 1961).

It should be noted that one of the most complicated factors is the difference to be found in the various combinations of inputs. Differences in the relative scarcity of inputs in the particular geographical areas where the firms are located as well as differences in the technological possibilities open to these firms, together with the long-run problem of technological change which alters the need for various types of trained people, tend to create great differences in the emphasis placed on "educationally-heavy" inputs.[2]

The class of hypotheses which were investigated in the inter-firm study was directly related to (a) the strength of the relationships between the market performance of the firm, and (b) the education and training of its employees. The market performance, or economic performance, can be expressed as the degree of productivity the firm achieves. Special care was taken in the selection of firms in order to avoid the pitfall, of which Bowen[3] writes: "It may be that industries which place a relatively heavy emphasis on educational inputs also happen to be industries which enjoy an above-average degree of market power, and that the apparent relation between relatively high profits and educational inputs is better interpreted as a reflection of the profitability of market power than as a reflection of the profitability of emphasizing educational inputs."

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[2] See William G. Bowen, Assessing the Economic Contribution of Education: An Appraisal of Alternative Approaches, in OECD, Economic Aspects of Higher Education. Paris, 1964, p. 180.

[3] William G. Bowen, op. cit. p. 181.

The factor "training of the labor force", is of great interest to manpower planning. It is needed to derive at educational goals, which are based on the particular needs of industry. Since we were attempting to assess the economic contribution of education, the manpower forecasting approach was related to educational planning as follows:

a. The first step consisted of determining the present occupational structure, or composition, of the labor force in the firms to be investigated.

b. The second step consisted of relating an "ideal" labor force to the growth target, that is GNP, of a particular future year; while

c. the third step involved the translation of those future occupations into educational requirements.

Once we decided to include the factor "education received" as a special part of the productive input of a firm, we related it directly to occupational classifications, and then related occupation to output of the firm. We were able to classify the labor force according to educational qualifications, and could build a model in which economic performance was - to a certain degree - a function of labor multiplied by years of schooling.

Although the results of the study are highly approximate, we feel that the approach can be developed into a scientific method for the estimate of current and future requirements for an expanding economy. Hardly any empirical research has previously been done in this field. Moreover, little systematic information is available regarding the adjustment of the educational structure to technological change.

The analysis was designed with a view to exploring methods of research rather than to finding definite answers to the technical problems. A total of eight firms were contacted. All companies agreed to make available the full range of personnel and economic data on a confidential basis. Thus we were able to collect a wide range of data:

1. Organization of the firm
2. Production methods, chief products
3. Financial structure
4. Employees
    a. Technical salaried employees
        aa. Male technical salaried employees
        bb. Female technical salaried employees
    b. Age distribution

    - c. Average period of employment
- 5. Occupational structure
    - a. Job descriptions
    - b. Salary structure for technical salaried employees
- 6. Educational structure
    - a. Educational qualifications of technical salaried staff
    - b. On-the-job training received (technicians only)
    - c. Further training (technicians and engineers)

At this point I would like to discuss briefly some theoretical aspects related to manpower utilization. Parnes enumerates four reasons why the conversion of occupational data into educational requirements is not "automatic" and why the development of a standard classification system in which jobs are grouped according to certain required educational standards, got stalled.[4] First, there seems to be no assurance that a particular kind of education, even if it is expressed in standard units of schooling, (number of semesters, etc.) represents the same degree or level of education from one country to another, or as is the case in the United States, from one state to another. The second argument runs as follows: the training and general education for a particular occupation, for instance, technicians, differs between countries. German technicians, as a rule, receive their training in engineering schools, while in Great Britain the sandwich-training is much more common as a preparation for this profession.

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[4] Herbert S. Parnes, Forecasting Educational Needs for Economic and Social Development (Paris: Organization for Economic Cooperation and Development, 1962), p. 37.

Third, even in a single state, such as Florida, there are many "avenues" leading to a degree, or to a certificate. In the case of manual workers we find substantial variation in formal educational qualifications, as well as among those workers who are in the same skill category. The fourth point to be considered is the fact that even jobs with the same title often require a different level of preparation. Here again we have to mention the technician, who with the proper type of secondary education, plus technical schooling, plus experience, may perform excellently. For the job classification of research technicians in the electrical companies we investigated, we found that one to two years of special technical-electrical and electronic training are required. As data on manpower utilization commonly do not differentiate between production technicians and research technicians, it seems impossible to equate the occupation "technician" with one or the other educational category.

Not all firms contacted seem to have recognized the importance of "skill input" planning over time. Only Firm 1, 2, 3, and 4 attached high value to the personnel function. Here more than once we were told that, in order to optimize production and sales, studies were made which focused on technological progress and how it effects each distinct product and that at the same time attempts were being made to "optimize" the skill input profile. The officers we spoke to were convinced that the personnel function should by no means be the last function to be modernized and that personnel policy ought to be a part of capital investment policy as a whole. One representative of Firm 2 pointed out to us that his management has plans to use the "educational qualifications scheme" as a hiring and selection device since it seems to indicate the "leaders" who are of great value to the company. We constructed age-earnings-education profiles and found - as was expected - that all profiles were upward sloping.

Since both income and schooling may be related to traits like imagination, drive, and ability, the upward sloping profiles also indicate that people with those traits are making a more rapid progress in the company than those not possessing them. Very little attention has been paid previously to age-earnings profiles relating to segments of the labor force in industry, and we made the attempt to interpret the data from the point of view of the individual firm. Immediately it occurred to us that the profiles by levels of education resembled the Salary Progression Schemes, which had been adopted by the firms.

Intuitive feelings were confirmed later when officers of the firms explained that they adopted salary progression systems as early as 1962. At this time, the need developed to reduce costs in order to be able to withstand the pressures of increased market competition. The underlying objectives were to achieve a balance between employee salary and training costs and to retain qualified technical personnel. The personnel departments of the firms thus worked out salary progression charts which, more generally, depict a number of career paths of technicians and engineers over their working years in the firms. Those schemes basically consist of a number of horizontal salary bands which represent the current market value of successive educational levels in the firms. An individual could, theoretically, follow an infinite number of routes, which would lead through various job levels toward an ultimate salary level.

We learned that there are significant costs involved in the hiring of "the right man for the right job." These costs increase, although disproportionately, with an "stepping-up" of the educational level of the personnel. Thus, the firms were very eager to develop tools which might help in determining the right man and his qualifications for the position. By means of the salary progression schemes they developed, the firms were able to ensure the "right" salary for their most promising personnel without over- or underpaying others.

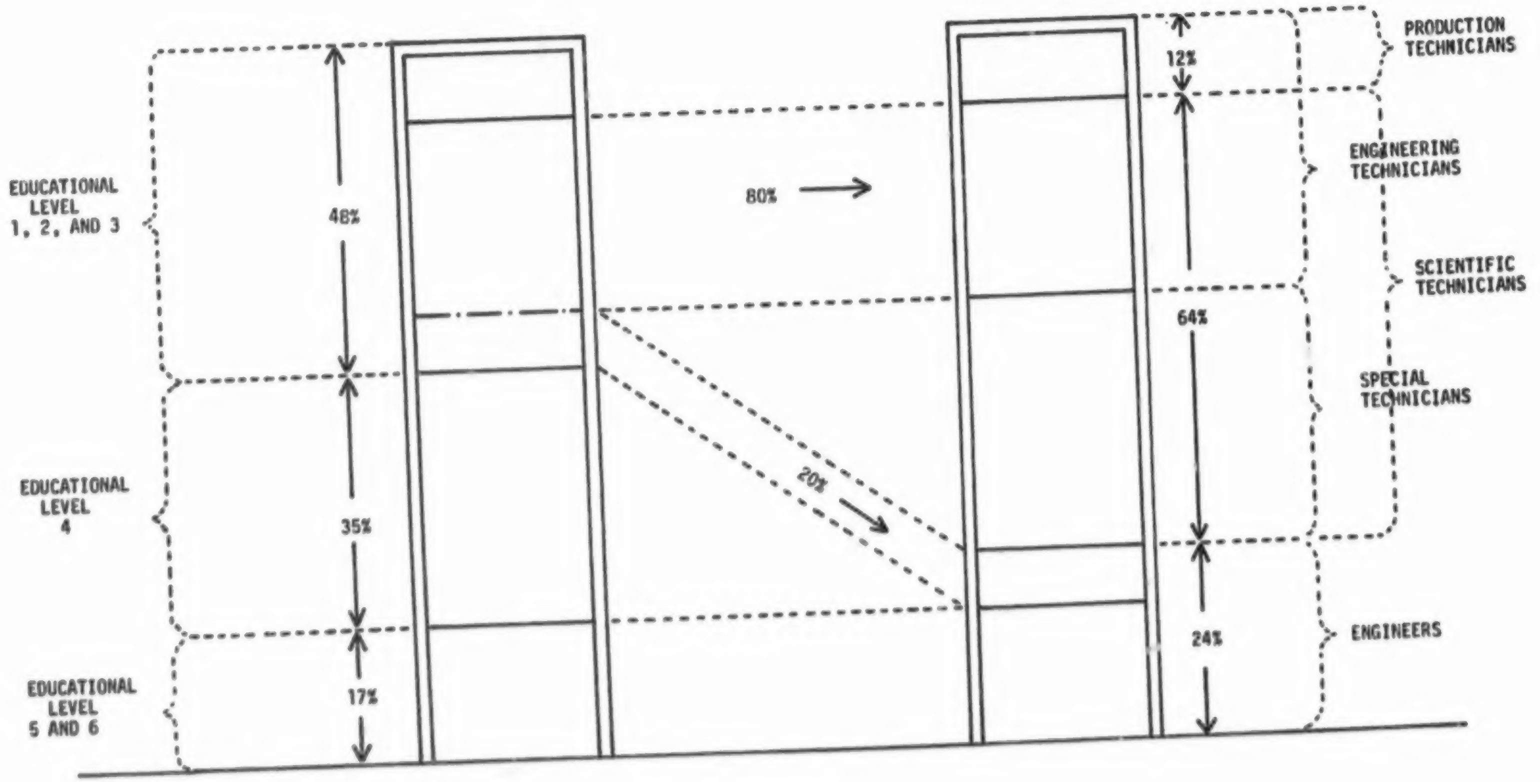
We were interested to discover that in many cases the progression grade of a particular individual would not match his job classification. Salary progression grades are constantly being reappraised, since it has been the experience in the past that many employees classified in educational levels 1 - 3 were making more rapid progress in the firms than those with educational qualification 5 or 6. In Fig. 1 we tried to illustrate this development. As we had salary progression scheme data only from firms 1, 4, and 5, we extrapolated our information to firms 2, 3, 6, 7, and 8, assuming that individuals in those firms have similar career paths. The two vertical columns in Fig. 1 indicate the total number of technicians and engineers in our sample. In the left column they are arranged according to educational classification, the right column shows their distribution in various job levels.

As can be seen, the "margin of error" -- as we called it for want of another term -- of the salary progression grade system is 20 per cent. Or, in other words, while 610 employees were considered as having a "potential" no higher than a technician, the same individuals progressed to jobs in the firms usually held by people with level 5 and 6 education.

All firms were well aware of this shortcoming, of this lack of accuracy of their salary progression grade scheme. It was pointed out, however, that the "built-in" mechanism for reappraisal has proven to be satisfactory in the past and that the companies were

FIGURE 1

MALE, TECHNICAL SALARIED EMPLOYEES (TECHNICIANS AND ENGINEERS) ARRANGED ACCORDING TO EDUCATIONAL ATTAINMENT AND JOB CLASSIFICATION


EDUCATIONAL LEVEL 1, 2, AND 3
EDUCATIONAL LEVEL 4
EDUCATIONAL LEVEL 5 AND 6
48%
35%
17%
80%
20%
12%
64%
24%
PRODUCTION TECHNICIANS
ENGINEERING TECHNICIANS
SCIENTIFIC TECHNICIANS
SPECIAL TECHNICIANS
ENGINEERS

able to recognize the "more able and more promising" individual as well as they were able to reappraise the potential of an employeee, whose job performance proved unsatisfactory.

We were forcefully reminded by the management of several firms that they invest in their educated labor in much the same way as in their physical capital. Management indicated clearly that the companies plan the use of highly qualified personnel over time in the same way as they plan the use of capital. These companies have recognized that it is of utmost importance to predict the rate of progress of automation and the accompanying changes in skill input. Within the framework of what the management called "active labor planning", the firms have already worked out plans to predict the employment at various skill levels that will be required in the future. The execution of these plans requires technological (or engineering) expertise; it requires economic analysis and also a great deal of psychology. In order to predict employment due to technological changes in the future, management wants to know:

a) The present technological methods used for the production of the complete line of products made;

b) What new processes and methods are on the way;

c) How fast each new technological development will spread and how large the percentage replacement of each currently used

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method by a new one will be;

d) What new skill inputs will be needed, and what the "skill input profile" will look like.

As was mentioned before, educational planning - employing the manpower forecasting approach - consists of the following steps:

(1) a calculation of the future occupational structure of the labor force; and

(2) the translation of the labor requirements by occupational categories into requirements by educational qualification.

The research results indicated that the main difficulty is connected with Step 2, where there seems to be no stable relationship between the occupation a person has and the schooling he has received.

Since the connection between education and occupation is fundamental to the manpower forecasting approach, we attempted to prove that there is indeed a systematic relation by constructing "Requirements-Attainments Matrices." The matrices consisted of the following elements:

Horizontal Row:

Here we would enter the required educational level for a particular job held in the companies, and

Vertical column:

Here we would enter the various educational qualifications of an employee. The matrices would yield the following information:

If the job requirements equal the educational attainments, which are specified for each job, then the observations will lie along the 45 degree diagonal of the matrix. In other words, if the observations fall along the diagonal, then this will indicate that the educational qualifications of the employees in the sample holding those jobs correspond to the educational requirements specified by the companies in their job-specification. Or:

In case our observations fall below the diagonal line, we have to assume that the employees, e.g., engineers and technicians, are what might be called "over-educated." That is to say, that they are employed in jobs that ordinarily require lower educational qualifications than they hold at present. Or:

In case our observations fall above the diagonal line, we have to assume that the people in our sample are "under-educated," that is to say, that they are employed in jobs which require higher educational qualifications than they possess.

Our first matrix, "job requirements of technicians and engineers employed before January 1, 1960," confirmed the hypothesis that there was no real consistency between a firm's hiring policy and practice, since only 9 per cent of all observations would fall along the diagonal. This indicates that the educational qualifications of the particular engineers and technicians do not equal the specifications set up by the companies.

It is interesting to note that 85 per cent of all individuals who had been hired before 1960 are, in a sense, "under-qualified." As the employment policy of the firms has not changed considerably during the past six years, we conclude that those "under-qualified" technicians and engineers never did match, in educational terms, the requirements specified by the firms. It must be assumed that their high rank today is the result of on-the-job experience and seniority.

The next matrix, showing job requirements for technicians and engineers who have been with the firms only after January 1, 1960, not only yields revealing information on educational-occupational relationships, but also indicated a balanced state of supply and demand in the labor market. This matrix shows 38 per cent along the diagonal, an astonishingly high number, which seems to indicate very clearly that during the past six years more attention has been paid to finding the "right" man with the "right" qualifications to match the specifications of his job. However, there were still 52 per cent, of those employed by the firms after January 1, 1960, whose educational qualifications did not correspond with the specifications set up by the firms; in other words, they were underqualified. The result is much better than this for technicians and engineers employed before 1960. Here we found the rate of "underqualification" to be 85 per cent.

These results made us believe that:

a) there seems to be hardly any justification for speaking of under-utilized educated manpower at a time when 52 per cent of a firm's technicians and engineers are, in effect, "underqualified" for the positions they now hold.

b) Although the opinion is widely held that there is no stable relationship between the position held and schooling received, we think that all segments of the labor force can be classified according to "education received" for purposes of forecasting manpower needs. We feel to be on safe ground in stating that

c) it is possible to draw up an educational profile of technicians and engineers which is based on the educational attainment of each individual, and

d) it is also possible, for purposes of forecasting the educational needs of a country, to relate the educational profiles to the actual positions in which those people are employed.

Just as an afterthought, it should be added that the findings clearly show that in most cases there is more than just a single educational requirement for each occupation. Since, in addition, there are several avenues an individual can take toward a certain position in a firm, we must also face the question whether on-the-job training is a substitute for or a complement to formal technical education. Most company representatives we interviewed regarding this question expressed their belief that training is complementary to, rather than a substitute for, formal technical education. This stresses the need of industry for people with a "General education" - background instead of specific professional preparation. It also implies that the need for specialized technical education in post-secondary institutions (junior colleges) is less pressing than seems to be the popular belief.

A few words now regarding the last part of the study: There are three basic methods which can be used to measure the capital value of education. First, one could calculate the years of schooling a segment of the population has received. Second, one could calculate and compute the replacement costs of educated labor, and thirdly, one could estimate the discounted values of anticipated future incomes. The question, naturally, is whether those and similar computations have any practical relevance to manpower forecasting.

Data had been collected in the United States which allow the calculation of rate-of-return figures on different levels of education. The calculation we had in mind involved discounting the age-earnings profiles constructed earlier, and then comparing the discounted earnings with the corresponding discounted costs.[5]

What did the preliminary results show? Our age-earning profiles which we constructed, together with calculations of the returns on investment in education, indicate that secondary and higher education have indeed a positive rate of return, which compares favorably with the return to capital. The second finding is that the monetary return is higher at the post-secondary school level than at the college level. This finding suggests that educational planners ought to look in this direction, as the educational system will have to adapt itself in future years to meet the increased demand. Third, although all firms investigated employed quantitatively different combinations of inputs, it could be observed that there was a systematic difference between the profitability of firms which place a heavy emphasis on education inputs and those firms which do not stress high educational levels.

Fourth, from the viewpoint of industry there is no "maximum" or "optimum" educational qualification a future technician or engineer should acquire. There exists a whole range of educational routes, or "avenues" leading to particular positions.

Most important, however, was the observation that there is a significant systematic difference between levels of profitability in firms which maximized their trained labor input and those using small amounts of this input.

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[5] There is a "built-in" weakness in this analysis since it is rather unrealistic to assume a state of perfect competition. The differences in earnings thus may reflect to a high degree the imperfections in the market, and not so much the different amounts of investment in education.

The implication then for forecasting educational needs is that future research should be carried out at the macro, or industry level, instead of focusing on the input-output relationships of the individual firm. This would make it possible to establish a sound basis for the prediction of optimal manpower needed to reach the economic growth target.

A Systems Look at Educational Planning

Friedrich Edding
and
Jens Naumann

Our intention is to assess and discuss critically some of the attempts to understand and solve problems of educational planning which have been made mainly by economists.

Planning presupposes goals. The general goal of education is to develop human capacities so as to enable individuals and groups to participate in and contribute to cultural life in the widest sense, comprising political, social and economic life as well as religion and the arts. The problems of planning we are interested in begin when the general goal has to be specified for a given planning set-up in space and time, e.g. a nation, a state, a region, a city, etc. Some of the specific questions to be answered, then, are:

(1) How many individuals should be lead by education how far towards
(2) which educational goals
(3) using which methods of instruction and curricula in
(4) which institutions and
(5) during which periods of their life
(6) in which localities

(7) under whose responsibility
(8) at what cost
(9) financed by whom
(10) using which criteria

Problems of setting specific goals, working out programs and measures of implementation seem to us to be at the heart of educational planning. In discussing the contributions of economists to these problems, we shall try to apply some guide lines of methodology provided by systems theory.

The Systems Approach - Or, Clothes Make the Man

To adorn discussions with terms like "systems analysis," "-design" or "-approach" has become fashionable. Those who were the first[1] to advance the ideas of systems theory, however, had a particular hope or intention which we feel compelled to state - at least in the field of educational planning - has not yet realized. They tried to suggest a remedy for a situation so pointedly characterized by Boulding:

"... the Republic of Learning is breaking up into isolated subcultures with only tenuous lines of communication between them - a situation which threatens intellectual civil war. The reason for this break-up in the body of knowledge is that in the course of specialization the receptors of information themselves become specialized. Hence physicists talk only to physicists, economists to economists - worse still, nuclear physicists only talk to nuclear physicists and econometricians to econometricians. One wonders sometimes if science will not grind to a stop in an assemblage of walled-in hermits, each mumbling to himself words in a private language that only he can understand."[2]

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[1] L. van Bertalanffy, K.E. Boulding, W.Ross Ashby, among others.

These early proponents of systems theory have indeed tried to provide a terminology broad and general enough to cut across established disciplinary limits and preconceptions. But more than that, they not only suggested a terminology but also a scientific methodology which can prove useful for interdisciplinary research. What often has happened, however, is that merely the term "system" has experienced a revival. After all, the term itself has long been used in the social sciences as is witnessed by such labels as "political system" or "economic system" which have been used so often and for so long that we do not even stop to think about what they mean. Likewise, the mathematician or econometrician is used to refer to "systems of equations." Indeed, for many people the term systems analysis is simply synonymous to any formal representation of an aspect of reality. This attitude was expressed by Dr. Knezevich during the recent "Symposium on Operations Analysis in Education"[3] who stated that systems analysis is nothing new, that when he was exposed to marginal analysis in his graduate courses in economics, that was indeed systems analysis.

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[2] Boulding, Kenneth E., "General Systems Theory - The Skeleton of Science," Management Science, Vol. 2, No. 3, April 1956, p. 198.

Obviously the term "system" is ambiguous and relative. It simply denotes any set of elements and their relations with one another. We would be the last to deny that, and are far from suggesting that there should be only one particular application of the concept. On the contrary, we hold that there is no system *per se* for all times and for all purposes and that when applying the concept to certain aspects of reality the methods and procedures of systems analysis can only be viewed by relating the particular features of reality to the respective observer or researcher, i.e. his capacities and intentions.[4] Systems change their meaning with the point of view, the conceptions and the goals of an observer or a relevant decision maker.

This precisely is the departure point for criticizing much of what is going on in the economics of education with respect to its relevance for educational planning. We propose, therefore, to measure the main currents of thought in the economics of education with the yardstick of some questions derived from this view of systems analysis.

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[3] Knezevich, Stephan J. "How Administrators Perceive Systems Analysis," paper read at the *U.S. Department of Health, Education and Welfare's* "Symposium on Operations Analysis of Education," Washington, D.C., Nov.19-22, 1967.

[4] Ashby, W. Ross, *An Introduction to Cybernetics*. London, Chapman & Hall, 1961, p. 106.

Planning apparently involves the formulation of goals and their transformation into actions which influence the behavior of a planning object. In other words, when we are dealing with questions of planning in general or educational planning in particular, we are concerned with a particular kind of system, broadly defined by specified intentions to deliberately intervene in the behavior of a planning object.

The Systems Approach and Planning

For purposes of illustration, let us think of an extremely simple system consisting of two elements. In systems terminology planning means the control of the behavior of one element (let's call it element 2) by the other (let's call it element 1).

Case A: Element (1) is only under strictly defined conditions able to perfectly control element (2)'s behavior, i.e. its output. These conditions are that element (2) reacts only to inputs received from element (1). It has no input from the environment of the two elements. Moreover, element (2) has a transformation function which relates to each identifiable state of the input it receives from element (1) one and only one identifiable state of its output variable.

Case B: If we assume that element (2) is not only influenced by element (1) but also by its environment, element (1)'s task of controlling element (2)'s behavior becomes much more difficult. Now, element (1) must not only perceive the influence of the environment before element (2) does, but it also must have a complete counter-strategy for whatever disturbances come from the environment. Finally, element (1) has to apply this counterstrategy fast enough so that it can neutralize the impact of the disturbances on element (2).

Case C: If element (1) does not have this counter-strategy available, or if it cannot react fast enough, or if it is not even capable of directly receiving and identifying the impact of the environment, element (1) can no longer perfectly control element (2)'s behavior. But the chance of a less perfect control still exists. It is called error-controlled regulation. In this case, element (1) reacts to the impact of disturbances from the environment once they have had an impact on element (2)'s output. As is readily seen, such a less than perfect regulation demands no perfect foresight on behalf of element (1) with respect to the disturbances from the environment, neither does it call for an extremely fast application of a perfect counter-strategy. The quality of an error-controlled regulation is judged on how much deviation between element (1)'s goal and the actual performance of element (2) is allowed to materialize, how long it takes element (1) to perceive this deviation and how successful it is in reducing it by changing its output, i.e. element (2)'s input. This, of course, is the basic feed-back model of systems control. We shall try to apply this model to the issues of educational planning.

Before, let us restate an important fact:
Systems theory tells us something about the necessary conditions for a planning set-up, i.e. what the nature of the conditions is that have to be met in order to "control" a particular planning object (in our above definition element (2)). It does not define on an a priori basis what the planning object is, i.e. what it is that we want to control. It therefore does also not stipulate on an a priori basis what the power of control of the planning subject has to be (in our above definition element (1)). This, moreover, implies that systems theory does not provide us with an a priori goal which the planning subject is supposed to realize. It openly declares that the answer to these questions are political, are value judgements. With respect to social systems, and this is what we are concerned with in whatever meaning we give to the term educational planning, this seems to be the only way out of the misconceptions into which some of the "economic approaches" to educational planning have lead.

These attempts have often been ridden by the fact that scientists in attempting to provide information for policy decisions had to anticipate exactly these political decisions for which their findings were supposed to provide the basis of information.

We should point out that however narrowly we define educational planning the representation of the planning object as one single element with one single output to be regulated would be an oversimplification. What we are confronted with, instead, is a set of elements with a number of different outputs which might be interrelated. The planning object, then, should be seen as a subsystem in a planning set-up. The increase in the size of the planning object from one element to a system will in all probability place a heavier demand on the regulator with respect to its regulating capacities: More different outputs have to be controlled, a larger variety of disturbances might make its impact felt. Any single regulator, be he a man or a machine, will have some limit in his regulatory capacity. The regulatory capacity can, in principle, be enlarged by increasing the number of individual regulators. In order to control a planning object system, the size of the regulator might have to be increased from one single element to a set of elements, which can be called the regulator system. This is the basic conept of "division of labor" or decentralization as expressed ina hierarchy. It does not, however, tell us automatically what the hierarchy looks like.

In The Long-Run We Are All Dead

(John Maynard Keynes)

In order to assess the contributions of "the economics of education" to economics properly and to educational planning in particular one is well advised to look at how the pendulum of economic doctrine has swung during the last two decades. It seems fair to characterize this period roughly as follows: Keynesian economics became generally accepted and for a number of years it looked as if it would outwin the classical and neo-classical outlook. But then what could have been the rear-guard battle of a dying school proved to be a veritable renaissance of the "homo oeconomicus" and of the other enlightened notion of a social mechanism called "the market forces," where God Almighty is replaced by an invisible hand. This renaissance, it is well to remember, had a much more decisive impact on "macro-" than on "micro-economics." The neo-classical revival linking arms with the traditional theory of the firm and consumer behavior was so far as micro-theory goes by no means as successful in making its impact felt than in the far less down-to-earth realms of general economics. Indeed, much of the criticism levied against the neo-classical premises is firmly based upon "micro-economic" theory about as old as the neo-classical revival.[5]

In the social sciences, it is often difficult to establish cause-effect relationships. This is true also of the relation between the neo-classical revival and what is commonly labeled "the economics of education." At least for the early days of this sub-discipline and at least for most of the current work done in it, either could stand as a proxy variable for the other. What, then, are the most important characteristics of Keynesian economics on one side, neo-classical economics as exemplified in the "economics of education" on the other?

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[5] See, for example, the ideas suggested in the works of R.M. Cyert, James G. March, Herbert A. Simon, Kenneth E. Boulding.

In this connection the first distinction usually made is that all the variants of Keynesianism neglected the "differentiated productive capacities of labor." As Mary Jean Bowman puts it: "They shifted the emphasis of a whole generation of economists from viewing labor as an active agent of production to viewing labor as a passive agent that would find employment only, if there were a high enough rate of "investment" and, most especially, of investment in the production of physical producer capital."[6]

So, the argument usually goes, it took the long-range secular outlook of the neo-classical school to discern the importance of factors like education and research for economic growth. This school attempts to assess the impact of a few "input factors" like "labor," "capital," "research and development," and "education" on one overall output variable over a time-period of 50 to 80 years. Even ambitious studies like the one by Denison[7] stipulate an essentially very simple relationship between these variables.

Too often, it is with the confrontation of the two labor concepts that the comparison between Keynesianism and the neo-classical school stops.[8] We have to realize, however, that the neoclassic growth-studies completely abstract from any political or institutional framework. They are not concerned, for instance, with who at the time were the decision-makers, what their decision variables and their decision latitude have been, why and how their respective preference-function (and thereby their decision rules) have changed.

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[6] Bowman, Mary Jean, "The Human Investment Revolution in Economic Thought," Sociology of Education, Vol. 39, No. 2, 1966, p. 117.

[7] Had it not been for the ingenious idea of treating quality changes in the labor force (as expressed by increasing amounts of schooling) as quantity changes of the labor input Denison might have been forced to give up the attempt of measuring the impact of education (as he was in the case of R & D). Denison, Edward F., The Sources of Economic Growth in the United States and the Alternatives Before Us. New York, Committee for Economic Development, 1962,p. 297, particularly chapters 7 and 21.

It is hard to interpret analyses on these lines against the background of even our simplified model of a regulator and an object system. It is, so to speak, a look from another star from which regulator and object system become a whole. The reason for this is, of course, that the neo-classical school just does not consider the relationship between decision-makers and decision-object to be much of an issue. For this school the "laws of the market" bridge the gap and provide both, the justification for neglecting the institutional set-up in the first place but then, also, making future-oriented policy recommendations on the basis of historical trends of a few aggregate variables.

On the methodological level, we have to contrast neo-classical economics with the attempt of Keynesian economics not only to introduce a time horizon commensurate with a particular problem (unemployment) but also to develop an action-oriented theory for a particular set of decision-makers (government). Furthermore, Keynesian economics has - for the first time in economic theory - formulated the idea of multiple equilibria of the economic system; the full-employment-equilibrium being one of many, possible to achieve by specific measures. This, of course, was aimed at the heart of the classical and the neo-classical school by saying that the "laws of the market" do not work the way neo-classical theory wants us to believe.

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[8] Bowman, Mary Jean, op. cit.

Keynesian economics can very well be interpreted against the background of our regulator/planning object set-up. This is exactly what Mary Jean Bowman highlights in her statement, by saying that Keynesian economics reduced "labor" to a passive agent of production (part of the object system). True as it is, this statement should be expanded to read that Keynesian economics also brought up the idea of an active agent or regulator (government), and that it attempted to define the instrumental variables of that decision-maker. The idea of multiple equilibria of the planning object, i.e. different degrees of under- or over-utilization of resources, and their link to various degrees of intervention or non-intervention on behalf of the regulator, i.e. monetary, fiscal or direct measures like public investment or consumption, can be interpreted as a first attempt to specify the transformation function linking a regulator's output, i.e. planning object's input, to the planning object's output.

The detached, secular and highly aggregate outlook of the neo-classical school has also been applied to the analysis of income differentials associated with different amounts of education. In and of itself the investigation of such differentials is nothing to be criticized, of course. In the first instance such efforts are nothing but the finding of signs or symbols void of meaning. It is the theoretical framework used to give such data a meaning which presents the problem.

However refined, after "due" allowance is made for various "non-market" forces such as discrimination (on the basis of sex, race, origin, for example) the income residual is taken to be that portion of the income attributable to the workings of the "laws of the market," i.e. productivity differentials ascribable to educational differences. Being market-oriented the neo-classical economists did not even raise the question whether "education" as well might belong to the set of "non-market discriminatory factors" like race, social background etc. irrespective of its productivity link.

Given the current income differentials the analysis proceeds with a secular interpretation by transforming them into life-income differentials covering a period from 35 to 45 years. It is with such a time-horizon then that the summary variable of an interest rate is computed, relating "returns" to "costs."

This interest rate again would be nothing than a symbol were it not for the traditional decision rule of neo-classical economics which provides it with a meaning and gives it a pragmatic direction.

In commenting upon Becker's and Mincer's work[9] which are outstanding examples of the theoretical reasoning and empirical investigations, respectively, of the neo-classical economics of education, Mary Jean Bowman refers to exactly this point:

"It is as easy to attack the Becker-Mincer work as to attack the theory of pure competition, which certainly does not dispose of it. Even when their assumptions are not satisfied, the analytical tools they provide form an extremely important point of departure for other future studies, using other assumptions and testing the validity of those assumptions in diverse institutional settings."[10]

As yet, however, it has to be shown that the summary measure of rates of return can be given any meaning outside the framework of neo-classical economics. As long as this has not been done it is difficult to follow M. J. Bowman's assertions that the respective analytical tools have any value.

The decision-rule which provides the symbol of an interest rate with a meaning roughly says: In order to optimize output equalize the individual rates of return. In order to achieve this, either increase the investment in those areas where returns are higher than in the available alternatives or rearrange your given investment budget. This, supposedly, leads to an equalization because the respective, individual curves of return will somewhere in their range show decreasing marginal increments.

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[9] Becker, Gary S. Human Capital A Theoretical and Empirical Analysis, with Special Reference to Education. New York, National Bureau of Economic Research, 1964, p. 187. Mincer, Jakob. "Investment in Human Capital and Personal Income Distribution," Journal of Political Economy, Vol. LXVI, No. 4, Aug. 1958, pp.281-302.

[10] Bowman, Mary Jean, op.cit., p. 128.

This is where the old "homo oeconomicus" enters the picture, who either knows "the market" in the first place (which would actually rule out the existence of interest rate differentials) or, at least, adjusts to it. The economic doctrine stipulates an *a priori* decision-rule and thereby an *a priori* rationality absolutely independent of any actual decision-maker, be he an individual or a group. The regulator - in our systems terminology - assumes the features of the "homo" and is somehow, the neo-classical economics of education do not specify more than the general decision-rule, supposed to optimize total output.

Pater Peccavi, Or, We Economists Aren't That Bad After All

If we stopped here the adherents of the neo-classical school would charge us with critisizing a theoretical starting point which, as they might think, has long been revised to take into account different decision-makers with different preferences, i.e. different decision/rules. Is it not that virtually every study of the economics of education states right at the beginning that it is well aware of the fact that economic considerations are but one factor in actual decision-making, next to the sociological, psychological, moral and other factors? Does not such an assertion give ample freedom to the actual decision-maker in formulating his own comprehensive utility function, in which surely, the economic factor appears but is not of overriding importance? Is it not up to him to provide the economic term with a meaning? At close examination this is nothing but the introductory "pater peccavi" before running into the same pitfalls they wanted to guard against. The reason is that the above mentioned, allegedly comprehensive utility function is of such a form that whatever weight is given to the economic factor, the traditional economic decision-rule remains intact. It stipulates a utility function that consists of additive, but mutually independent terms, the economic factor being one of them. In such a function the application of the traditional economic decision-rule is still a necessary although not sufficient condition for the optimization of overall utility. To be precise: This statement is true as long as the weight given to the economic term is positive. But even if such a particular form of utility function would be held by a regulator, indeed, a whole regulator system, this variety of the economicsof education has only told us something about the regulator's long-term goals, nothing about how to translate them into the reality of the planning object and virtually nothing about the transformation function relating specific measures of the regulator to identifiable behavioral changes of the object system.

The charges against the neo-classical variety of economics of education for planning purposes can then be summarized as follows: Because of its more or less openly declared belief in the mechanics of the "laws of the market," it is virtually not concerned with the problem of how to translate goals into actions of a specific regulator or regulator system. It focuses on the formulation of goals on the basis of an a priori decision-rule or preference function, which centers either exclusively on "economic factors" or presupposes that they are independent of other elements.

The "Manpower Approach" - A Savior from Neo-Classical Pitfalls?

The so-called manpower approach to educational planning is usually credited with avoiding the pitfalls of the neo-classical line of reasoning. It does not center on linking income differentials to various levels of schooling but rather looks at the proportions in which people with different educational backgrounds are employed in various sectors of the economy and society. These proportions are then linked to activity indices of the respective sectors. Doing this, the manpower requirements approach acknowledges, of course, the "investment" or "capital-character" of at least some portions of some kinds of education. By avoiding to discuss the issue of remuneration of the factors of production it is, however, less burdened with assumptions regarding marginal productivities and all it entails with respect to the form of production functions and the behavior of individual decision-makers. The time-horizon for this type of analysis involves usually 15-25 years because of the length of the "production process" of education.

If it is possible to determine what the future activity levels and their respective input coefficients will be, the manpower requirements approach is able to provide us with numerical statements on how many people with different educational backgrounds will be required for specified activity levels.

Parnes and Bombach did much to conceptualize this approach, the OECD sponsored a variety of such investigations within the framework of the Mediterranean Regional project. In West-Germany, Hajo Riese has recently published a study on the long-term requirements of university graduates.[11] He wrote this originally as a memorandum for the German Council on Higher Education (Wissenschaftsrat). The Council was looking desperately for reliable scientific guidance for its policy problems: Should the council recommend a general or a partial expansion of the system of higher education and if so, by how much?

Riese's answers have strongly influenced actual decisions. His main results were that during the seventies and eighties the number of students as of 1964 will on the whole be high enough to satisfy the requirements of the economy. He obtained these results by stipulating a 4% overall growth rate of the GNP and a consistent set of activity levels for a number of different sectors. One interesting result was that only about 25% of highly qualified manpower (university graduates) are actually employed in manufacturing industries, the rest being in "service sectors" like education, health and government.

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[11] Riese, Hajo. Die Entwicklung des Bedarfes an Hochschulabsolventen in der Bundesrepublik Deutschland. Wiesbaden: F. Steiner Verlag, 1966.

The advantages and disadvantages of the manpower approach come clearly into focus if we interpret it against the background of our planning set-up. Because of its virtually unlimited possibilities of disaggregation and alternative break-downs this technique has the potential of being a valuable method of organizing data according to the areas of competence of the individual elements within the regulator system. As an analytical tool it has indeed the potential to play a dominant role in the efforts of a large regulator system to develop a consistent set of policy measures vis-a-vis a complex planning object.[12]

If this technique, however, is not seen against the background of interaction of a regulator system and an object system, i.e. if the activity levels of the various sectors are not viewed as being subject to considerable influence on behalf of the regulator system, then this approach is much more similar than dissimilar to the neo-classical variant. If the various input coefficients are not considered as being both, the expression of political norms and of technological necessities, this approach ascribes an independence to the socioeconomic system which is simply non-existent. The most an application of the technique can lead to under such circumstances is a forecast. Here, we are entering, as we observed already above, the vicious circle in which a scientist is asked to provide information as a basis for political decisions of a regulator system, but is forced to anticipate exactly those decisions for which his data are supposed to provide the basis of information.

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[12] Kornai discusses alternative uses of I-O techniques depending on their purposes of application. In particular, he contrasts the western, "statistical" I-O tables with their "industrial branch" break-down with the supplementary, socialists "chessboard" variety which identifies "addressees" (decision-makers) and their area of competence and is used for plan coordination or bargaining.
Kornai, Janos. Mathematical Planning of Structural Decisions.Amsterdam, North-Holland Publishing Co., 1967, Chapter 1.

Without being aware of it, the neo-classical school bases its criticism of the manpower-approach on exactly this vicious circle, when it rejoices in pointing out the inaccuracies of forecasts based on this technique. Forecasts are bound to prove "wrong" if they do not succeed to integrate the relevant decision of the regulator system for the time period they cover. In general, forecasts still tend to prove the more inaccurate the more detailed they are - if the corresponding complexity of the environment and/or the regulator system is not taken into account. Because of the neo-classical tendency to work with very aggregate production functions or use rate-of-return as indications for the direction, not the amount of investment allocations it is impossible to pinpoint their empirical shortcomings. They can't be "wrong" because of their built-in immunization.

Asking economists to come out with exact forecasts on the basis of their knowledge of the workings of the political and economic system per se means asking for the impossible. How is a single scientist or a group of scientists working independently from a regulator system supposed to be able to cope with the "disturbing impacts" (at least some of them being various decisions of the regulator system) when even in a planning set-up, where the scientists attempt to integrate the decisions of a regulator system, they are forced to work with the model of error-controlled regulation because of the complexities of the task?

By essentially stipulating that the changes over time in the coefficients of the input factors and the development of different activity levels depend on some inner logic of the socio-economic system, Riese and the OECD have employed the manpower technique on a level which is essentially on pari with the rate-of-return analysis.

We summarize therefore that the manpower requirements approach has a great potential for planning purposes if its crucial analytical parts, coefficients and activity levels, are viewed as being subject to influence if not control of the regulator system. If this is not taken into account numerical statements of "requirements" ten or twenty years hence exhibit a pseudo-precision which is as inoperational as the indication of investment priorities on the basis of rate-of-return differences. Moreover, the idea alone of "economic manpower requirements" presupposes again the neo-classical schizophrenia with respect to the utility function of decision-makers.

The Social Demand Approach to Educational Planning

Some of the national committees responsible for drawing up "plans" for the long-term development of education have recently expressed the view that they preferred not to use projections of manpower needs for their purposes. The British Committee on Higher Education whose findings became known as the "Robbins Report" felt that the planning of general and higher education should rather be based on a comprehensive view of individual and societal needs. The Westgerman Council on Education (Deutscher Bildungsrat) whose memoranda and recommendations are just beginning to appear in print, took the same view. These national committees, like those of other nations, gave much thought to the so-called social demand approach to educational planning and there is no doubt that this approach has met with a more widespread interest than the methods of returns calculations and manpower projections.

There is quite a bit of confusion, however, about how to understand the term "social demand" and consequently how to make this concept operational in educational planning. Most of the time the term has served as an expression of general dissatisfaction with the notion that economic growth, maximization of life income and catering to the requirements of the labor market should be the main guide-lines for educational policy. In a way it was the rallying-cry of the sociologists and educators against the dangers of economism in educational research and planning. Educators, incidentally were caught in an understandable love-hate relationship to the above outlined economic reasoning, rejecting it to the extent it intruded into the domain of goal-setting, welcoming it to the extent it underlined their importance and provided "scientific" arguments for increasing their salaries or overall resources earmarked for education.

Here, then, are four definitions for social demand as abstracted from some of the recent writings in the field:

1) "Social demand for education means the effective demand for places in formal education."

With respect to the compulsory part of formal education, "effective demand" is often simply taken to be the number of places in formal education necessary to accommodate the respective age-groups. With respect to non-compulsory higher education or specialization during the compulsory stage the term is given an economic interpretation as the measurable willingness of households to spend in a limited period certain amounts of time and money for education. Sometimes, it is proposed to use the tool of income elasticity in order to assess the future effective demand, given a particular disposable income. If the question is asked by what factors this income elasticity is influenced, an economist is likely to turn to the rate-of-return argument, linking, again, income incrementals to additional costs for the individual. To the extent that these economic arguments are predominant in the reasoning it might be more appropriate to call the concept the "private, economic demand" for education.[13]

Sociological research in this area has provided us with some insight into the importance of more general environmental factors of an individual and his perception of them.[14]

The next three definitions of social demand do not center on the individual but rather refer to political values of a community:

2) "Social demand for education is the immanent need of the democratic society (present and future) for the improvement of human capacity by formal and nonformal education."

3) "Social demand for education is an expression of securing equal chances for all individuals to get all the education they can absorb," or, similarly

4) "Social demand for education means the demand derived from the principle of giving all individuals an equal opportunity to get all the education they ask for."

These definitions of social demand are decidedly non-economic in the sense that they are not based upon an economic rationale. As they stand, they are inoperational as long as it is not defined what the "needs of a democratic society" are or what "equal opportunity" means. In order to have any relevance for educational planning at all these general principles have to be translated into clear-cut goals which a regulator system can strive to achieve and against which its actual performance can be measured. If this is not done, we perpetuate a political immunization strategy which justifies whatever action or in-action a regulator system has taken by calling upon a principle rather than a goal. What these principles do achieve, however, is placing the responsibility of goal setting into the realms of politics. It is, then, no longer made believe that the social science disciplines can provide such goals out of a value-free body of theory.

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[13] See, for example, Blaug, Mark, "An Economic Interpretation of the Private Demand for Education," Economica, Vol.XXXIII, No.130, May 1966, pp. 166-182.

[14] See, for example, Morgan, James N., David, Martin H., Cohen, Wilbur J., Brazer, Harvey E., Income and Welfare in the United States. New York, McGraw-Hill, 1962.

As an example, in Baden-Wuerttemberg, Germany, the Secretary of State for Cultural Affairs, made the normative decision, that the "needs of a democratic society" as his government presently conceives them, consist in bringing up the age-specific gymnasium graduation rate from 8% to 15% within a time-period of 15 years. In defining this goal it was clear that since it is normative, it is subject to change.[15]

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[15] For a short survey of this and a number of related discussions on educational planning in Germany, see Edding, Friedrich, "Educational Planning in Western Germany," The World Year Book of Education 1967, Evans Brothers, London 1967, p. 100-116.

We have critisized the "economic approaches" to educational planning not only with regard to their logic of establishing goals, i.e. the regulators input, but also with regard to their view of the relationship between regulator system and object system. The same, then, should be done with regard to the social demand approach. The picture we see here is as dismal as that of the "economic approaches." In a sense it is even worse.

Although often extremely narrow-minded, economics has at least some history of being concerned with the relationship between a regulator system and an object system as is witnessed by Keynesian economics, for example. The other social sciences, however, sociology in particular, are often even more descriptive. This is not only true of the traditional, "German-type," verbal variety but also of much of the data-oriented "American variety." The reason for it is that cross-sectional or time-series investigations of the socio-economic determinants of actually observed effective demand for education may be perfect in a statistical sense, yet be of very limited use to the regulator system as a whole or an element in it.
Some of the reasons are the following:

1) The "explanatory variables" do not belong into the set of policy variables of the regulator system, because the regulator system either did not exist during the time period covered or did not have or employ particular policy variables.
2) The findings may pertain to a population different from the one

the regulator system is concerned with. This may refer to the level of aggregation of the empirical study, which might have been chosen so that the interests of the researcher or statistical requirements are fulfilled but not those of the regulator system as a whole or parts of it. Or it may simply mean that the data and the findings refer to some time in the past, too far back to be relevant to the present-day needs of a regulator system.

As a consequence, questions relating to who should intervene where and how mostly did not figure prominently in "social demand" investigations. It appears, therefore, that the social demand approach to educational planning like his "economic" counterpart still has a considerable way to go to become relevant for planning purposes.

By constantly reminding ourselves of the basic features of a planning set-up we obtain criteria for judging the relevance of social science research for planning purposes.[16] This is not to say, that these criteria should completely substitute those of "scholarly excellence" or "scientific relevance." It is a reminder, however, that the latter do not necessarily imply the former. It reminds us that academic freedom may mean among others the freedom from political relevance.

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[16] It is interesting to note that the US Office of Education has recently realized this problem and is now slightly moving away from applying "l'art pour l"art" criteria in awarding research contracts. What it tries to do, instead, is to devote at least a portion of its research funds to areas in which it is interested for purposes of intervention.
"Educational Research Programs of the Office of Education: An Interview with Dr.R.Louis Bright,Associate Commissioner for Research," Sociology of Education,Vol.40, No.2, 1967, pp. 158-169.

For a European it is sometimes surprising to see how well the notion of educational planning is accepted in the United States - as long as he does not realize that what his American counterpart is talking about is apt to be something much more limited than he is likely to refer to.

Discussions on educational planning in the U.S. are more often than not confined to the educational establishment in a rather limited way. They tend to center upon

1) the learning process, i.e. the interaction between students or groups of students and the teacher, or other means of curricula presentation. This could be called the classroom level.
2) the functional aspects of individual educational establishments, which could be called the educational plant level, and
3) the relations between individual educational plants at the school system level.

Whereas the problems dealt with at the classroom level lie within the traditional framework of education as an academic discipline, those at the educational plant level and the school system level are traditionally regarded to be the responsibility of educational administrators. As long as problems of planning fall within the limits roughly set by these three levels, educational planning in this country is a relatively uncontroversial issue. Even more, the questions we have raised regarding the relationship between a regulator system and a planning object have been well understood. This does not yet seem to be the case when education is seen in a broader social context. Some of the big problems this country is facing and apparently has decided to do something about are the issues of poverty, the negro-problem and the crisis of the big cities, all of which are largely overlapping.

Paraphrasing the term "social demand for education" by saying "social demand on education" would highlight the fact that great hopes were and still are placed on education as a key factor in alleviating these problems. Hopes, which we feel, are largely based upon the neo-classical variety of the economics of education, with its aggregate, long-range outlook and its belief in the workings of the market mechanism.[17]

The course of events has shown us, that the mere provision of some kind of education will not help much to cope with these problems. This has been realized as is witnessed by the mere existence of the poverty program, the model cities plan and the rapid growth of the number of urban problems research centers. On the educational scene it is demonstrated by attempts to develop "community schools" or "educational parks" which are intended to be more responsive to the general social problems of a community.[18]

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[17] See, for example, the statement in Time Magazine, Dec. 8, 1967, p. 38: "How to Cut the US Budget"

. . . .

"Education: Because it has great social consequences, is economically productive and the key to solving the nation's racial problems education should be handled with extreme care in the effort to save money. Univ. of Chicago Economist Th.W. Schultz calculates that the steadily improving education in the US labor force has increased real national income by one-fifth. But Congress is impudently making some penny-wise reductions in worthwhile federal programs. . ."

To the extent that these developments indicate the willingness to plan, we think that a systems look as outlined in this paper may provide a methodological basis for interdisciplinary, planning-oriented research. It is a starting point which leads us to ask and investigate relevant questions: Is the given data gathering set-up adequate for the needs of a regulator system (a city administration, for example)? Should changes aim at a common data base for all elements in the regulator system or should it rather aim at decentralized data-banks connected via an inventory system? Is the given hierarchy of elements in the regulator system able to cope with the tasks it is presently facing or do areas of responsibility have to be reassigned or newly created?[19] The "economics of education" to the extent that it tries to establish a rationale of its own will fall victim to new developments of thought as outlined in this paper. "Educational planning" will have to be integrated in a broader framework of social planning.

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[18] Marker, Gordon A., "Planning for Educational Parks," paper read at the U.S. Department of Health, Education and Welfare's "Symposium on Operations Analysis of Education," Washington, D.C., Nov. 19/22, 1967.

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[19] A recent investigation of educational policy making in New York found that since 1940 there has been an increasing trend towards isolation of the school administration from the city government which, among others, meant that the school administration was extremely unresponsive to more general problems like "quality education" for negroes.
Gittell, Marilyn, "Professionalism and Public Participation in Educational Policy-Making: New York City, A Case Study", Public Administration Review, Vol. XXVII, No 3, September 1967, pp. 237-251.

A Strategy of Human Resource Development

Irvin Sobel

Compared to the precision of some of the quite sophisticated and relatively elaborate models for linking economic development with occupational and educational requirements, what I am about to say may seem rather trite and certainly lacks any semblance of exactitude. All of the discrete elements which underlie the following comments and subsequent analysis have been sufficiently stated before so that many of you participating here are aware of their basic portent. What I am basically going to attempt to say is the following: namely, there is no single or unique, but in fact, a variety of possible allocation of educational resources which can result from a given demand for human resources. This would strongly suggest, therefore, that the model or system employed for determining educational "inputs" must be determined by a society's human resource development strategy and the critical choices which that society makes in implementing its chosen strategy.

These choices are not given or determined, instead they are a factor of the society's political and social system and level of development. Consequently, just as a given level of growth when related to a particular industrial structure, may be accompanied by a diverse number of human resource mixes (viewed in terms of occupational structure and occupational coefficients),any given human resource mix can be accompanied by significantly different educational mixes to generate the appropriate human resources. The planning model or system chosen must be related to that particular society's human resource development strategy and to the critical policy choices it makes to implement these choices. What I propose to do in this brief analysis is to delineate the choices which must be made, either explicitly or implicitly, and to examine some of the implications of these choices upon the allocation of educational resources.

Planners in the manpower field, and educational planners in particular, are obviously included in this classification. They face two basic and interrelated problems. These problems must be dealt with in any strategy of human resource development.

The first of these problems in developing economies is of central and overriding importance to this discussion. It is a shortage of critical skills. Teachers, doctors, engineers, technicians, agricultural scientists, high-level managerial and administrative talent, technicians, skilled labor, middle manpower, foremen, supervisory personnel, and secretaries are in scarce supply in most developing countries. In these countries there is growing awareness that the faster the growth process, the more acute are the shortages of skills. In fact, growth in skill- and high level manpower is intensive. The rate of increase in demand for most high level occupations is well over twice the economic growth rate.

The second problem is unemployment. The simple facts are that the more rapid the rates of economic growth, the higher the rate of growth of unemployment. Such has been the case, at least in Venezuela, Jamaica, and Puerto Rico. Studies of other countries are likely to show a similar pattern.

The explanation of this phenomenon is two-fold. One factor is the very rapid growth of population (between 3.5 and 4.0 percent a year) as is the case in Venezuela. The second factor is the emergence of urban centers which hold a magnetic attraction for the rural population. People do not want to spend the rest of their lives digging yams when they learn that there are other possibilities. Migration into the cities is proceeding at a much more rapid rate than the expansion of urban employment opportunities, resulting in widespread unemployment in the cities. The capital intensive nature of many of the growth industries may result in relatively few jobs in the initial phases. Rural underemployment is, thus, replaced by urban unemployment.

While unemployment is not the direct concern of our discussion today, it does have an important indirect effect. Resources which could be made available for educational purposes, i.e., human capital generation, may have to be diverted for employment creation in order to relieve the general social and political tensions which may and do arise in developing economies whose rate of growth, even when highly impressive by historical standards, does not satisfy the exploding expectations of members of the society.

A Strategy of Human Resource Development

A strategy has two components: a set of goals, and a rational program for attaining such goals. A strategy is a plan of action to meet explicitly defined goals. A strategy of human resource development must be part of a broader strategy for national economic development.

Five elements of a human resource strategy must be distinguished:

1. A program for the development of formal education, including primary, secondary, higher, and vocational education.

2. A program for development of people who are already employed. On-the-job training programs cannot be neglected in favor of the formal educational program. This includes some attempt to delineate those skills and attributes which can best be taught on the job or in industry and company training programs as opposed to

the formal educational system.

3. The building of incentives. Incentives are needed to induce labor mobility into critical shortage areas. Iran, for example, has only one nurse for every nine doctors; incentives are needed in the form of wages and status to make the work of nurses more attractive. Similarly, incentives are needed in Nigeria and elsewhere to make the position of the agricultural technicians, who work and live in rural areas, more totally rewarding.

4. Policies regarding the import and export of high-level manpower. Many developing countries must import doctors, engineers, technicians, and other high-level personnel. The new nation of Malawi, for example, must import qualified personnel to fill seven hundred posts in the civil service because Malawi has less than one hundred college graduates. In all developing countries, a choice must be made--are foreign personnel to be permitted to enter the country permanently, or only until they train local counterparts? A manpower export strategy must also be developed. A survey of five developing nations showed that only fifty per cent of the students sent to study in the United States had returned after five years. Each country must determine on what terms it will permit students to go abroad.

5. Employment strategy. A strategy must evolve which could consider the level of employment as one of the elements of a manpower strategy.

Policy Decisions in a Strategy of Human Resource Development

In building a strategy of human resource development, choices must be made in seven critical policy areas:

1. A choice must be made regarding priorities for investment in primary, secondary, or higher education. Top priority cannot be assigned to every type of education. It may be necessary to choose between increased primary education and inadequate secondary and higher education, on the one hand; and limited primary education and high-quality secondary and higher education on the other.

2. A choice which frequently involves a balance or compromise between quantity and quality in education must be made. High-quality education may require that the educational base be small because the resources available are not sufficient to provide high-quality education for the mass of the population. Columbia has eighty per cent of the primary-age population in school, yet in many cases, the schools have no pencils, paper, or textbooks.

These first two choices involve the consumption versus producers education dichotomy and the extent to which education, as a consumer good, is to be made available to all. Equally involved is the shape of the educational pyramid. Attempts in a developing country with a low G.N.P. and a low level of expenditure on education, (less than the 5 per cent of G.N.P. recommended by UNESCO experts) to educate people en-masse and provide at least an elementary education for all may lead to the great bulk of expenditure resulting in very little if any human capital. On the other hand, concentration in producer type of education may mean a highly educated but small elite, a large body of narrowly educated--in a political, social, cultural and citizenship sense--technicians and almost mass illiteracy for the remainder. Societies can make all sorts of choices as to the amount of education which is provided the typical semi-skilled and even unskilled worker. Our society provides, for the majority, a high school education before individuals start to acquire more direct investment or producers human capital while other societies provide 5 to 8 years (Russia and Germany). These choices, which are related to prevailing societal attitudes governing the overall willingness to supply education not directly related to economic performance, are determinants of the education system chosen.

Other related questions which follow are: How specialized should career patterns be in terms of time of choice of options and the openness of the options at all levels. Another crucial decision which has to be made relates to the number and variety of opportunities which a society is willing to make available for second and even third chances and for "late bloomers." Developing societies and even most traditional developed economies probably cannot afford keeping options open for second and third chances and waiting for the late bloomers to bloom.

3. In higher education, a choice must be made in the distribution of students between law, the arts, and humanities, on the one hand, and science and engineers, on the other. It must be remembered that the cost of educating a science or engineering student is at least three times that of educating a student in law. Thus, an increase in scientific and technical education will mean a very drastic cut-back in enrollments in other faculties. Political pressures, however, may make a curtailment of enrollment very difficult.

This issue also can be stated in terms of the extent to which the educational system and the distribution of educational opportunities in specific curricula (especially a higher education) is related to the countries specific "human resources" needs--by occupation and sector of the economy--or to which free choice

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In non-Communist developed countries, twenty-five per cent of all students in higher education are in science and engineering, in Communist countries, forty-five per cent; in developing countries less than 10 per cent.

based on the aspirations of individuals and groups in the society has been allowed to determine not only the amount of investment in higher education but its distribution among different programs. The United States and Israel are probably at one end of the continuum and Russia at the other. The result for Israel is a tremendous brain drain since the economy cannot absorb all the high level manpower from high energy physicists to physicians to professors in the humanities which it generates.

4. Another critical choice must be made between the many different ways of providing certain types of human resources (viz, engineers) given that a variety of combinations of different types of schooling, experience, on-the-job training, and upgrading from lower levels are feasible. This issue not only is related to the adequacy of channels of recruitment, entry and transfer to occupations, but to the rigidity of educational specification in licensing and in other formal requirements for entrance.

The nature of the institutional framework (high and middle level labor markets) is thus a significant factor in determining the mix between formal education, on-the-job training, upgrading and transfer. The freedom with which the institutions in the labor market can make adjustments, the variety and availability of general purpose education and training, (i.e., the relative proportions who have acquired a trainable base upon which certain training facilities) are the key determinants of the mix.

The data for engineers and technicians in this country suggest the great variety of education, training, and on-the-job experience which are possible, at least for the United States. Of the 852,000 self-reported engineers in the 1960 Census (822,000 employer-reported or 96 per cent of the self-reported according to BLS and NSF joint studies) a little more than 2/5 or 42.5 per cent had engineering degrees. If we were to extend the definition of engineer to encompass those trained in the sciences but with some engineering study the proportion would rise to 42.5 per cent. If we were to include all degree holders who took a sufficient number of courses to qualify engineering as a field of study, the proportions (45 per cent) still would fail to reach the 50 per cent mark. Only by including other degree holders with no engineering backgrounds but who call themselves engineers do the proportions reach 55 per cent.

For technicians, the extent to which a given course or pattern of preparation--in more technical terms fixed educational coefficients--prevails, is even substantially lower. This speaker recently served as co-director of a study on technical occupations alleged to be in short supply in the St. Louis and Chicago labor markets which found that less than 20 per cent of the technicians (tool and die designers, metal and mechanical technicians, and electronic technicians) entered after a prescribed technical course either in a technical school or junior college. Only for tool and die markers do the proportions of those in the field who went through a prescribed path--in this case apprenticeship training--(47 per cent) approach the proportions of those who took traditional paths (graduation with a degree in engineering) to become engineers. Varying combinations of night school and after work schooling, on-the-job training, upgrading, self and correspondence type of education were responsible for the great bulk of technicians. This suggests that in a society such as ours where a large number of persons--even at the lower shop level--have some amount of higher education, plus a general cultural habituation to mechanical relationships, alternative routes or different educational coefficients are not only possible but preferable in increasing the flexibility of the labor market.

These data also would indicate that any model or system of relating occupations requirements to the educational system must take these diverse paths into consideration. Should it attempt to build a system upon fixed coefficients--namely, two years of technician training or four to five years for an engineering degree--the number of posts in either technical training institutes or in engineering schools would be significantly over-estimated and educational resources substantially malallocated. While the same number of possible diverse paths or educational coefficients may not exist for a developing economy or even in a more traditional developed one, it can be contended that even in both categories of development there are a variety of possibilities which must be incorporated into the model chosen for relating occupational and educational requirements.

An important issue which involves a policy choice lies in the administration of vocational education. The extent to which this task is divided between formal vocational education provided by the education system, continuing education in conjunction with employment and on-the-job training must be determined. Developing countries have attempted to provide too much formal vocational training of a highly specific nature and have not distinguished in all too many cases, between the specific processes indigenous to particular industries and general vocational knowledge necessary to provide a trainable base.

5. A choice must be made concerning the utilization of the wage system to provide incentives. A country must determine to what extent it is going to change the existing wage structure in order to induce workers into shortage fields or into less attractive parts of the country. The extent to which a government is willing to interfere with the existing wage hierarchies,

which may involve traditional elites, may be decisive.

The problem of reconciling the preferences as well as the capabilities of individuals with the manpower needs of the country is very important. Before manpower is channeled into shortage areas by a manipulation of the pay structure, it must be determined whether the shortage is permanent or temporary. Once salaries are raised, it is difficult to reduce them, even if the desired result has been achieved.

6. A choice must be made between viewing education as an instrument of individual development or viewing it as a means of meeting the needs of the State. The United States has taken the former view and permits its students to choose their own courses of study and their own occupations. Communist countries have viewed education as a means of meeting State needs. Developing countries have a difficult choice between these two alternatives. Where critical shortages exist, it may be costly to allow freedom of choice in education. Can a developing country, which lacks high-level manpower, afford to permit its foreign-trained university students to remain abroad? Each country must determine the degree of free choice which it is willing to grant its population.

7. Another choice must be made between which occupations and curricula should be developed internally in the educational

system and which should be left to foreign institutions. Size of programs or demand for people in this field, availability of educated people to teach in the field, the expected rates at which students sent abroad will return, and the availability of foreign scholarships all are deemed elements. In fact, a whole series of choices must be made about foreign training and its desirability. Many countries are finding that even the apparent provision of free foreign education and training is an expensive gift or even Trojan horse.

Planning for human resource development should not be a peripheral or residual component of overall economic planning. Because of the crucial importance of human resources, manpower planning should be at the center of overall planning.

The general implication of these comments is to suggest that those engaged in educational planning must incorporate into their coefficients these critical decisions indicated above. The choices which either implicitly or explicitly cannot be avoided are matters of broad societal determination and cannot simply be made by the planners no matter what their technical competence may be. This would strongly imply that with different choices involving different labor market and human resource strategies, the educational mix for producing the requisite human resources could vary.

The educational system which evolves is then very much determined by a society's social, political and cultural orientation. The economist can make certain generalizations about the relative efficiency of different educational mixes in a cost effectiveness sense in generating the needed supplies of human resources, but since other socio-cultural and political values can be of equal or greater importance than mere allocative efficiency, he himself cannot choose the mix.

Summary

The Researcher and the Human Resources Decision-Maker: A Dialectic of Planning

Jens Naumann

Having been asked to summarize my impressions from the conference I suddenly realized the dilemma of such a task.*

One is either led to assume the role of the detached, benevolent observer who is rewording the summaries of the individual papers, compiling essentially, something like an annotated bibliography. Such an approach leads all too often to a chamaeleon-like behavior on the part of the observer, resulting in a number of distinct paragraphs connected by nicely worded phrases. And apart from the dubious economies of time the reader had better gone directly to the summaries of the individual papers.

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*Klaus Hufner, Max-Planck-Institute for Educational Research, has contributed much to the main reasoning of this summary and the Edding/Naumann paper. The present author is bearing, of course, the sole responsibility for the shortcomings of this presentation of the argument.

The other, equally unattractive because unfair, alternative consists in rejoicing in the fact that one has been awarded the opportunity to make one's own position prevail. Attempting to avoid Scylla and Charibdis I hope not to have stranded but I might have touched the ground of the latter.

I. In choosing a title for this summary I paraphrased Churchman and Schainblatt's "The Researcher and The Manager: A Dialectic of Implementation."[1] They address themselves to the question of how the relationship between the operations researcher and the manager has been seen in the relevant literature of the last twenty years. The term "implementation" refers to the way in which the manager may come to use the results of operations analysis. The "problem of implementation" - as they define it - is the problem of identifying the activities and/or institutional arrangements which permit the most efficient relationship between the two.[2] Since all of the following papers address themselves directly or indirectly to issues of planning the question of the relationship between the researcher and the potential user of his product becomes paramount. Without wishing to identify any of the authors with the respective classifications suggested by C & S, we nevertheless feel that their classification scheme might provide an interesting perspective for the conference papers. Therefore, we will briefly sketch the reasoning of C & S and use it as a framework for relating the conference contributions to one another.

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[1] Churchman, C.W. and Schainblatt, A.H. "The Researcher and The Manager: A Dialectic of Implementation," Management Science, Vol. 11, No 4, February 1965, pp. 69-87 (From now on abbreviated as C & S).

[2] C & S, p. 71.

II. Churchman and Schainblatt suggest a classification scheme for the various positions expressed on the relationship between researcher and decision-maker which is based upon the following two basic propositions or their negations:

A(A'): Implementation does (not) presuppose that the manager understands the researcher.

B(B'): Implementation does (not) presuppose that the researcher understands the manager.

The resulting four classification possibilities are labeled "Separate-Function," Communication," Persuasion" and "Mutual Understanding."

The separate-function position holds that the researcher's or scientist's responsibility consists in analyzing a particular problem and presenting a formal solution to the decision-maker who either accepts or rejects it. A somewhat more sophisticated version stipulates that the formal solution has to be translated into an "operational" one, spelling out the detail of physical or organizational changes necessary to accomodate the formal solution. The role of the manager, however, is somewhat left in the dark. Of course, it is his responsibility to decide on whether or not the recommendations are accepted, but on what criteria is he supposed to base his decision?

"He may do so by examining the past record of the scientist or implementor; or by intuition he may come to feel that the recommendations are acceptable. In either event, he cannot be said to understand the scientist, in the sense of responding to the scientists behavior. His mere acceptance (or rejection) is not understanding; the Separate functions of manager and scientist preclude the need for any such interaction."[3]

The communication position centers on the notion that implementation is synonymous with understanding science. This implies that the decision-maker must be made to understand the scientist's efforts and his procedures. Once this need is realized, communication appears to be a straightforward process with science and the scientist in charge of educating the decision-maker.[4]

The persuasion position has a somewhat different image of the manager. It argues that it might be impossible to educate the manager to be more of a scientist. Even if it can be done, the first step still consists in breaking down his "innate" resistance to new ideas and scientific procedures. In order to "sell" science to the decision-maker the scientist has to know him well enough to be able to influence his attitudes and behavior. A prerequisite is educating the scientist to enable him to overcome the predisposition of the manager.[5]

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[3] C & S, p. 75. The authors give examples for the type of research which is most commensurate with the respective positions.

[4] C & S, pp. 76, 77.

C & S find most of the recorded statements on the relationship between the researcher and the manager to belong to one of these three positions. A common characteristic of all three is that in the final analysis they hold the manager responsible for a possibly inefficient relationship. Having listed the shortcomings and naiveté of each position, they suggest the fourth one which at the present time they consider to be programmatic. For reasons of space we cannot restate their formal definition of the mutual understanding position. Let it be noted, though, that they suggest something more than mere "appreciation" of the counterparts. They rather suggest an interaction which would substantially affect the decision-making of the manager, as well as the process and the kind of scientific activities.

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[5] C & S, pp. 79-82.

The four positions can be displayed in the following compact way, which we adapt for our purposes:[6]

An Effective Relationship between Human Resources Decision-Maker and the Scientist presupposes that . . .

The Human Resources Decision-Maker The Scientist	Understands the Scientist	Does not understand the Scientist
Understands the Human Resources D-M	Mutual Understanding	Communication
Does not understand the Human Resources Decision-Maker	Persuasion	Separate Function

III. CORREA addresses himself to the problem of an optimum enrollment policy for underdeveloped countries which currently do not have adequate facilities to accomodate all the potential students in the school-age population. He asks how the educational system should be expanded in order to enroll both the existing backlog as well as all the new entrants to the relevant age-bracket. He analyses the problem in terms of a linear programming model; the objective function calls for a minimization of investment outlays given the above mentioned constraints. His optimum policy - illustrated by a numerical example - consists in spreading the necessary increase in facilities over a certain period of time, rather than instituting a crash-program.

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[6] C & S, p. 86.

The basic stand of this paper appears to be consistent with the above mentioned separate function position. The scientist develops a very general, formal model which purports to be relevant for a big class of individual situations. To be directly relevant for a particular situation one would have to adjust the parameters and use the actual empirical values for the respective variables, the basic features of the model remaining the same.

KRAFT'S paper on inter-firm comparisons of the use of highly qualified manpower is similar to Correa's in the sense that it does not address itself to any particular decision-maker. It is, indeed, much more descriptive than prescriptive, if one wants to use these labels. Kraft reports on a pilot study for eight firms which provided him with data relevant to the main premises of the manpower approach. He investigates the relationship between the hierarchy of occupations and the respective educational qualifications as spelled out by the management. A cross-tabulation of the labor forces according to these characteristics reveals that in 1960 only 9%, after 1960: 38% of the labor force did indeed conform with the occupation/education classification, whereas the rest was "underqualified" in terms of the classification. Kraft points out the apparent importance of on-the-job training and notes that there is no indication of underutilization of highly qualified manpower. He concludes that this type of research on the industry-level promises to provide the information on educational requirements necessary to meet economic growth targets.

Before moving on to the other papers which sometimes rather sharply criticize work done on the above mentioned lines let us be clear about one point. Because of its virtually non-existent concern with problems of application, the separate-function philosophy is most susceptible to result in research which - to use a well-known expression - is more oriented towards the "basic research" rather than to the "development" end of the R & D spectrum. A result of this orientation may be a preeminence of scientific procedures, problem-awareness and self-restriction which originates in the world of "academiae" and its departments rather than in its environment. To belittle the achievements of this orientation - even in the "economics of education" - would be foolish, for one has to realize that a more "development-" or "application-" oriented outlook has its price, too. It puts a new set of constraints on the scientist and his work linked to the problem of practicability and his relation to a particular decision-maker. His work might have to deal more and more with specifics, might have to transcend disciplinary boundaries and will probably lend itself less to generalizations and disciplinary theory-building. The result may very well be a loss of new scientific stimuli and a decrease in the opening-up of new lines of scientific inquiry. This will probably be conceded even by the most vocal critics of the "economics of education," who - it seems to us - essentially start from premises different from the separate-function position.

DEWITT and SOBEL give a staggering account of the current state of human resources development in the United States and in a number of underdeveloped countries. DeWitt distinguishes sharply between educational and human resources planning, the former referring to the development of the educational system per se, the latter to the link between the educational and the economic system. He describes the educational situation as being in utter imbalance with the needs of the economic system, which is at least partly the legacy of the euphoria of education and economic development during which the plans of Addis Ababa, Tanarive and Karachi were formulated. In this sense he takes issue with some of the predominant lines of thought in the early "economics of education" which might be catalogued as originating from the separate-function position. DeWitt does not confine planning to the use of formal procedures but rather discusses some of the political and institutional problems involving the (set of) decision-maker(s). To the extent that he conveys the impression that science has the techniques and procedures for planning available, if the political decision-makers were only rational enough to accept them, his contribution could be considered as belonging to the persuasion position.

EDDING/NAUMANN go one step further in their review of some of the planning techniques. They charge that the traditional approaches to educational planning have too strong a bias toward the descriptive side and that to the extent they were used as a basis for prescription or policy-making they provided fallacious reasoning. They favor a position which is keenly aware of the scientist's counterpart. This position influences the subject and procedures of research (problem-oriented rather than discipline-oriented) and calls for an explicit inclusion of the decision-maker system. To the extent that their position implies a revision of the scientists role as well as that of the decision-maker their paper might be grouped with the mutual understanding position. In a sense they echo the cry for a particular kind of interdisciplinary research voiced in firm-oriented operations analysis. To date, however, this suggestion - as indeed the mutual understanding position by C & S - seems to be little more than a still ill-defined call for reassessment.

DAVIS gives an account of the development of formal educational planning models at the Center for Studies in Education and Development at Harvard. His description of a number of static, quasi-dynamic, and dynamic linear programming models, of quadratic programming, simulation and analyogue models is followed by a rather sobering outline of the shortcomings of these models. A number of his general observations appear to have a bearing also upon Correa's paper.

It seems to us as if Davis' criticism is also directed against the separate-function position which probably provided the philosophical starting point for the line of investigation he discusses. Is it not that position which is most apt to provide the ground for ever-increasing sophistication without providing more or better help to the decision-maker? Might not this attitude have led to the proliferation of general formal planning models at the expense of investigations directed towards the analysis and integration of the decision-making set-up?

JASTRAM finally addresses himself to some of the major organizational problems of a planning set-up. His description of recommended organizational changes in the California State-level system of educational administration is based on the assumption that the Department of Education can be interpreted as the switchboard of a giant information network. An analysis of the tasks of that organization appears to suggest a combination of what in industry has been called the "functional" and the "project" organization. Such a set-up seems to better provide the kind of administrative flexibility needed to cope with suddenly realized, possibly complex problems. He analyses in some detail the staffing and financing aspects of the proposed reorganization.

In the sense that Jastram addresses himself to organizational patterns of the decision-maker system that are both prerequisites for and constraints of planning activities he seems to address himself to the problem area whose neglect is at the heart of most of the criticism voiced in the other papers.

My possibly biased impression is that the criticism expressed at the conference pointed to the need for a research orientation integrating the basic problem area of Jastram's paper with the "classical" forms of formal treatment of human resources planning.

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